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NAVAL POSTGRADUATE SCHOOL

Monterey, California

DATA FROM THE OPTICAL DYNAMICS EXPERIMENT (ODEX)
R/V ACANIA EXPEDITION OF 10 OCT THRU 17 NOV 1982
VOLUME 1: CTD AND OPTICS PROFILES

by

James A. Stockel
James L. Mueller
Hasong Pak
David Menzies

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Monterey, California 93943

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During the Optical Dynamics Experiment in Oct. and Nov. 1982, the R/V Acania occupied 184 stations along a transect near 35 N from the California coast to 142 W and in a fine scale qrid covering the subtropical front near 32 N, 142 W. This report presents the hydrographic and optical profile data acquired with the Acania's CTD/ROSETTE package at these stations.

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DATA from the OPTICAL DYNAMICS EXPERIMENT (ODEX)

R/V ACANIA EXPEDITION of 10 OCT thru 17 NOV 1982

VOLUME 1: CTD and OPTICS PROFILES

(Temperature, Salinity, Density, Sound Speed, Optical Beam Attenuation, Fluorescence, and Dissolved Oxygen)

by

James A. Stockel *
James L. Mueller *
Hasong Pak **
David Menzies **

Chief Scientist:

James L. Mueller

* Department of Oceanography
Naval Postgraduate School
Monterey, California 93943

** School of Oceanography
Oregon State University
Corvallis, Oregon 97331

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1.0 INTRODUCTION

Between 10 October and 17 November 1982, the R/V Acania occupied 184 scientific stations in the eastern N. Pacific Ocean (Figs. 1 and 2, Appendix A) to observe spatial variability in optical, physical, biological and chemical properties of sea water. This expedition was part of the Optical Dynamics Experiment (ODEX), a three-year ONR-sponsored research program aimed at predicting optical propagation in the upper ocean. The experimental objective of ODEX is to characterize vertical distributions of optical properties in the open ocean, and their associations with vertical distributions of temperature, salinity, density, phytoplankton pigment concentrations, nutrient concentrations, and primary productivity: these are the ingredients needed to initialize and test 1-dimensional model predictions of changes in vertical optical propagation in response to atmospheric and radiation forcing of the upper ocean. The variables measured at ODEX stations are itemized in Table 1, and instrumentation used to measure these variables on Acania is described in Appendix B.

The design of ODEX called for continual repetitive sampling at drift stations aboard the R/P FLIP (supported by the tug VIKING) to acquire time series of profiles of the ODEX variable set (Table 1). These time series were to be coupled with a description of three-dimensional variability to be acquired by profiles aboard ACANIA at a station grid designed to characterize mesoscale variability in the primary ODEX site (Fig. 2). To determine the spatial extent over which observations in the ODEX site were representative, additional stations were occupied along the section from the California coast to the ODEX site, and from there south to 30 N (Fig. 1). Independent, cooperative support was also obtained from the R/V DeSteiguer, which measured profiles of a subset of the ODEX variables at widely space stations along a track extending from San Diego, CA to the ODEX site (near 34 N, 142 W), thence to 44 N, 149 W, and returning from there to San Diego. Hydrographic profiles from a subset of the DeSteiguer stations were kindly provided to us by Roswell Austin (SIO/Visibility Lab., San Diego, CA) and have been used to complete the vertical section of large scale meridional hydrographic structure presented later in this report.

Stations were occupied as rapidly as possible, day and night, to optimize synopticity of the resulting 3-dimensional description of the upper ocean. The CTD/ROSETTE package (Appendix B) was utilized on almost every station (except for a few stations where the unit was inoperative). Standard CTD cast depth was initially 500 m, but was reduced to 300 m after station 40 due to leaks in the pressure casing of the flourometers (as explained in Appendix B). Casts to 1000 m (or deeper) were made at stations 46, 73, 77, 134, 168, 175 and 179, to obtain oxygen and salinity calibration data and comparative water samples, and also to characterize physical and optical properties of the deeper water masses. Water samples were obtained from the CTD/ROSETTE at all stations for chlorophyll, nutrient and particle count analyses; water samples for C-14 primary productivity measurements were obtained at selected stations as indicated in

Appendix A. BOPS profiles, and water samples, were obtained on most daylight stations, including a few stations where the CTD was inoperative. OSU-K and TIP profiles were obtained at only a few selected daylight stations (Appendix A).

Volume 1 (the present volume) of this data report presents only those variables profiled using sensors on the CTD/ROSETTE package during the R/V ACANIA ODEX expedition of 1982. Particle size distributions measured with a Coulter Counter from water samples obtained with the CTD/ROSETTE are reported in Volume 2. Chlorophyll concentrations measured fluorometrically from water samples obtained with both the CTD & BOPS ROSETTE samplers, and interpolated vertically with the aid of fluorometer profiles, are reported in Volume 3. Nutrient concentrations determined by auto-analyser measurements of water samples obtained with CTD and BOPS rosettes are reported in Volume 4. Variables profiled with the BOPS system are reported in Volume 5. Variables profiled with the OSU-K package are reported in Volume 6. And finally, spectral irradiance profiles measured with TIP are reported in Volume 7.

The hydrography, beam attenuation, and fluorescence profiles reported here are available through NODC on 9-track, 1600 bpi computer compatible magnetic tape in the format described in Appendix D. Where appropriate, computer readable digital data will be separately provided to NODC for archival with Volumes 2 through 7 of this data report.

TABLE 1: VARIABLES PROFILED at ACANIA ODEX STATIONS

VARIABLE	PRIMARY INSTRUMENTATION PACKAGE [1]
Temperature	CTD/ROSETTE [2]; BOPS [3]; OSU-K [4]
Conductivity	CTD/ROSETTE [2]; BOPS [3]; OSU-K [4];
Beam Attenuation c(660)	CTD/ROSETTE [2]; BOPS [3]; OSU-K [4]
Fluorescence (Chlorophyll-a)	CTD/ROSETTE [2]; BOPS [2];
Dissolved Oxygen	CTD/ROSETTE [2];
Chlorophyll-a (extracted)	CTD/ROSETTE [5]; BOPS [3, 5];
Nutrients	CTD/ROSETTE [6]; BOPS [3, 6];
Vector Irradiance [7]	BOPS [3]; TIP [4];
Scalar Irradiance [8]	OSU-K [4];
Carbon-14 Productivity	CTD/ROSETTE [4, 9];
Particle Size Distribution	CTD/ROSETTE [10];

NOTES:

1. See APPENDIX B.
2. Profiles presented in this volume of the data report.
3. Measurements made at most daylight stations (Appendix A).
4. Measurements made at selected daylight stations (Appendix A).
5. Filtered water samples analysed using fluorometer after pigment extraction using acetone.
6. Water samples from rosette bottles analysed with autoanalyser.
7. Downward and upward vector irradiance profiles measured at 12 wavelengths (Appendix B).
8. Downward scalar irradiance (globe collector) profiles measured at the same 12 wavelengths as vector irradiance (Appendix B).
9. Water samples from rosette bottles innoculated with C-14 and incubated on deck.
10. Water samples from rosette bottles analysed using Coulter Counter.

2.0 DATA ACQUISITION.

The standard Niel-Brown measurements of temperature, conductivity, pressure and oxygen concentration, and also analog signals from the Sea-Tech beam transmissometer and the in situ fluorometer, were digitized using the 16-channel analog-digital converter in the Neil-Brown unit and transmitted to the deck unit using the standard Neil-Brown FSK protocol. Output from the Neil-Brown deck unit was logged, and annotated with ancillary time and location data, using a special version of the Acania Data Acquisition System (a program written in BASIC on an HP9835 computer) and recorded on 9-track, 1600 bpi computer compatible tape. On each downcast, data were recorded without interruption as single 9-track file, with backup recording of the acoustic FSK signal on a 1/4 inch tape recorder. A supplementary record of each downcast was also subsampled at approximately 5 sec intervals, using an OSU provided Apple-II system which plotted profiles of each variable in real time. Each up-cast was also recorded as a separate file on the DAS 9-track tape, but no analog backup recording was made. The upcasts were interrupted to trip 10-liter Nisken bottles at depths selected by inspection of the real-time Apple-II profile plots. Water depths for bottle samples were selected at maxima and other critical points in optical, physical and fluorescence profiles. (During deep calibration casts, bottle depths were selected in depth ranges of nearly constant salinity and oxygen, and to obtain as wide as possible ranges of salinity and oxygen concentrations.) Care was taken, after each bottle firing pulse, to allow the oxygen probe to restabilize at or near the pre-firing value before resuming the upcast; this procedure increased station time slightly, but ensured the backup and quality-control value of the upcast profiles.

Ancillary data were recorded both automatically by DAS (including intake temperature and conductivity, latitude, longitude and meteorological state variables), and manually in CTD log sheets and the Operations Log. During data processing, the header information was edited using these logs and the ship's bridge log. This procedure was especially important for ensuring navigational accuracy outside the range of good Loran-C coverage, where positions were fixed at typically 3 hour intervals using navigation satellites in the Transit series.

Calibration data were obtained during the deep casts at stations 46, 73, 77, 134, 168, 175 and 179. These casts were made without fluorometers due to the pressure limits of the casings of those units (see Appendix B). Water samples obtained on these casts were analysed for oxygen concentration using titration methods, and for salinity using an Auto-Sal salinometer (Appendix C).

Several combinations of Niel-Brown CTD units and/or fluorometer units were used at the various stations on this expedition. Refer to the more detailed discussion in Appendix B. Calibration differences relevant to the two CTD units are discussed in Appendix C. The archive tape records are flagged to indicate the operative configuration at each station (see Appendix D).

3.0 DATA PROCESSING.

The digital data from the CTD and Beam Transmissometer were calibrated using the procedures summarized in Appendix C. Each CTD profile was first automatically edited to retain only monotonic pressure increases with time on downcasts (monotonic increases on upcasts), and for static stability of computed density profiles (within 0.008 sigma-t units). After removal of data points not meeting these criteria, the data were bin averaged over 2.5 dbar pressure intervals, with gaps of up to 10 m filled by linear interpolation. Profiles with data gaps larger than 10 m were set aside for inspection and special treatment (i.e. either replacement with the upcast, or possible truncation). Sigma-t, specific volume anomaly, dynamic depth relative to 0 dbars, squared Brunt-Vaisala frequency, and sound speed were then calculated from average temperature and salinity in each 2.5 m bin. Beam Attenuation meter data were then used to calculate average 1-meter transmission values T for each 2.5 m bin, and the transmission was then converted to beam attenuation coefficient as

$$c(665) = \ln(1/T) \quad m^{-1}$$

(Zaneveld and Bartz, 1978). Refer to Jerlov (1976) for further information on c, the beam attenuation coefficient, and its relationship to absorption and scattering of light in seawater.

Header information, including date, time, station identification and location data were manually edited for consistency with the CTD, Operations, and Ship's Logs and recorded in header records with each station record in the format described in Appendix D. The data are grouped into files on the archive tape corresponding to stations along contiguous zonal or meridional sections (Appendix D and Figs. 1 and 2).

Algorithms used to process the CTD data were those of Lewis and Perkins (1981) for salinity, Millero, et al. (1980) for density, and Chen and Millero (1977) for sound speed. The software implementations of these algorithms were all tested against the verification data provided by these authors. Computations of specific volume anomaly, dynamic depth, and N^2 (using vertical density derivatives computed using reciprocals of specific volume anomalies) were tested against published examples to ensure precision consistent with the measurement precision of the Neil-Brown CTD calibration.

Fluorometer data are reported as voltage (ranging from a nominal 0.3 bias for no fluorescence to 5 volts full scale; the 0.3 volt baseline bias offset varied somewhat from unit to unit), with no attempt to convert these voltages to either absolute fluoresence units or to chlorophyll-a concentrations. The method by which the fluorescence voltage profiles are used to interpolate over depth between discrete chlorophyll-a samples is described in Volume 3 of this data report.

4.0 DATA PRESENTATION

In sections 4.1 & 4.2, the data are summarized as vertical sections, to a pressure depth of 300 dbars, showing large scale zonal structure near 35 N and large scale meridional structure near 142 N respectively.

The zonal section near 32 N (Sect. 4.1), may be divided roughly into 4 distinctive regimes on the basis of temperature, salinity and density. The inshore California Current regime lies over the continental shelf and slope between the coast and the strong ocean front near 125 W. An offshores California Current regime lies seaward of that front to approximately 129 W, and is bounded by the frontal structure between stations 45 & 46. The distinctive temperature/salinity signature transition across the front at 129 W is illustrated in Figs. 3a (east side of the front, in CCS water with variable surface layer salinities ranging from 32.5 to < 33.5) and figure 3b (west side of the front with upper layer salinity near 34.6). T/S curves nearly identical to those illustrated in fig. 3b characterize all water masses found in the domain between 129W and the strong salinity front near 136W between stations 47 & 49. The horizontal salinity gradient in this front is partially compensated by the horizontal temperature gradient, with a weak density gradient as the result. The T/S characteristics of the water masses to the east and west of this front are illustrated in Figs. 3b and 3c respectively. The T/S curve of Fig. 3c characterizes all stations west of 136 W in waters north of the Subtropical Front (see below).

The east-west transect (Sect. 4.1) also divides into 4 optical regimes, which are bounded by organized optical gradient features associated with the aforementioned temperature, salinity and density fronts. A strong optical gradient is associated with the front near 125 W, which is also the strongest density front and separates the CCS structure over the continental shelf and slope from the CCS to central gyre transition regime further offshore. We have not yet examined T/S characteristics of water masses separated by this front - we will do so in related publicatons.

The north-south section from 30 N to 44 N near 142 W, has been filled in with use of R/V DeSteiguer CTD profiles kindly provided by Roswell Austin (SIO Visibility Laboratory, San Diego, CA, personal communication); the ACANIA & DeSteiguer jointly occupied Acania station 77 (Fig. 1), DeSteiguer then proceeded north to 44 N and several degrees of longitude west of the ODEX site (for presentation, however, these stations are projected on the 142W meridian). There are 2 fronts present in the north-south hydrographic structure. The first is the Subtropical Front near 32 N in the ODEX mesoscale sampling area, with strong temperature, salinity and density gradients in the upper 300 m. The other is the Subarctic Front near 40N. The distance between these two fronts is approximately 700 km.

Restricting our attention to the Subtropical Front, the T/S characteristics of water on the north side of the front are illustrated in fig. 3c, and those of waters to the south (e.g. at stations 78 - 80) are illustrated in fig. 3d. Both of these T/S curves fall within the envelope of East Central North Pacific (ECNP) water as defined by Sverdrup et al. (1942), and are designated here as ECNP/N and ECNP/S following the usage of Niiler and Reynolds (1984). The T/S point at 300 dbar is approximately the same in both water masses, but at lesser depths the southern water mass is notably saltier and warmer than the northern water mass.

Vertical structures in physical and optical variables across the Subtropical Front are illustrated in finer detail in Section 4.3 (with ECNP/N to the north and ECNP/S to the south). The front is best detected by the horizontal salinity gradient in the upper 150 m, where it is partially compensated by the horizontal temperature gradient, with a resulting weak yet significant density gradient. Below 150 m, the temperature and density gradients are the best indicators of the front. These characteristics are consistent with those observed by Niiler and Reynolds (1984). Optically, the water mass regimes in this area are characterized by a maximum in c(665) (suspended particle maximum) found ubiquitously at the base of the surface mixed layer, which we take to be that upper layer with N < 0.01 sec^-1. The particle maximum at the top of the thermocline is slightly, but significantly stronger in ECNP/N water than in ECNP/S water, and is weakest in the region of frontal mixing (as detected by mixed T/S characteristics illustrated in Fig. 3e). The mixed layer depth was also shallowest in the frontal regime (i.e. between stations 100 and 102), where it shoaled to approximately 40 m, as compared to 50-60 m in ECNP/N and 70 m in ECNP/S water. The horizontal distribution of mixed layer depth is illustrated in panels a and b of Section 4.8.

Vertical profiles characterising variability along the above section are illustrated in Section 4.4 (see the discussion in that section). The most notable features of these profiles are the strong salinity interleaving signature in the upper mixed layer of the frontal zone, and the ubiquitous particle maximum in the c(665) profiles.

Another meridional section across the Subtropical Front is illustrated in Section 4.5. The water masses are reversed here, with ECNP/N to the south and vice versa, and horizontal gradients of salinity and temperature are somewhat sharper than those of Section 4.3. Otherwise, the frontal characteristics illustrated in Sections 4.3 and 4.5 are very similar.

The reason for the reversal in relative positions of the water masses between Sects. 4.3 and 4.5 is obvious from inspection of the horizontal maps of variable distributions illustrated in Sections 4.6 - 4.8. These maps clearly show that the ODEX observational grid covered part of an eddylike feature in the Subtropical Front. The section of 4.3 is located near 141W, with temperature, salinity and

density characteristics separating the N & S water masses in a "normal" manner (i.e. consistent with large scale distributions). Section 4.5 lies near 142-30 W, where recirculation of the southern water mass has folded the front into an eddylike pattern with an apparent reversal of water mass distributions.

The folded pattern of the Subtropical Front in the ODEX site is most clearly visualized in the dynamic topography at 0, 50 and 100 dbar, and more weakly at 200 dbar (Sect. 4.7). The drift trajectory followed by the R/P Flip, from north to south (as illustrated in Section 4.7 by circles and dashed lines), is clearly consistent with the trend of dynamic height countours. Furthermore, drift velocities in the southern portion of Flip's trajectory are consistent with the order 20 cm/sec geostrophic velocities calculated from the local dynamic topography.

Surface mixed layer depth is contoured in the second panel of Sect. 4.8; this "conventional" mixed layer, defined by N < 0.01 sec^-1, closely approximates the mixed layer depth that would be determined by inspection of sigma-t profiles, or by a sigma-t threshold. Surface mixed layer depths are deepest in the SE & NW quadrants of the grid (occupied by ECNP/S water), shallower (typically 50 m) in the ECNP/N water mass near the top central part of the domain, and shallowest in the frontal mixing zone itself.

A shallower mixed layer depth, plotted in the first panel of Sect. 4.8, is defined by presence of a weaker stratification (N^2 < 5 x 10^-5). Part of the distribution of the shallow mixed layer may be an artifact of asynoptically sampling a diurnal cycle of near surface stratification by heating during the day, which is destroyed by convection at night. However, the pattern of some organized features in this shallow layer suggest that at least some of these weak, shallow pycnoclines are associated with water mass interleaving in the frontal mixing zone.

The beam attenuation maximum at the top of the thermocline is strongest in ECNP/N and weakest in the frontal zone, and its contour patterns generally mimic those of the physical variables (Sect. 4.8, panel c). The distribution of the depth of maximum c(665) closely follows that of mixed layer depth (Sect. 4.8, panel d).

The horizontal distribution of vertically integrated c(665) in the top 200 m (an indicator of total suspended particle volume) is less organized than that of other variables, but generally follows a trend of higher values to the north and lower values to the south (Sect. 4.8, panel e).

Sound speed at the sea surface (Sect. 4.8, panel f) is generally lower in ECNP/N than in ECNP/S water, but its contours show only slight manifestations of the presence of the Subtropical Front.

Profiles of temperature, salinity, density (sigma-t), c(665), fluoresence, and dissolved oxygen concentration are presented in Section 4.9 for each station where a CTD cast was made (as noted in Appendix A). For each station, profile plots to a depth of up to 500 dbar are presented in two panels, with temperature, salinity and sigma-t in the left panel, and beam attenuation (c(665)), fluorescence (volts) and oxygen concentration in the right panel.

NOTES:

FIGURE CAPTIONS

FIGURE 1: R/V Acania's cruise track during the Optical Dynamics Experiment (ODEX). Scientific stations occupied during the period 11 October 1982 through 17 November 1982 are plotted as circles; numbered stations indicate the direction of progress along each trackline. The geographic coordinates of each station, and the number of casts by each major instrument package are tabulated in Appendix A. Stations 50 - 51, and 82 - 166 are concentrated in the inset area (See Figure 2).

FIGURE 2: R/V Acania's cruise track and station locations in the primary ODEX site (stations 50-71 and 82-166). This area is marked "see inset" in Figure 1.

FIGURE 3: Temperature/Salinity diagrams for selected water masses encountered during Acania's ODEX expedition in Oct/Nov 1982.

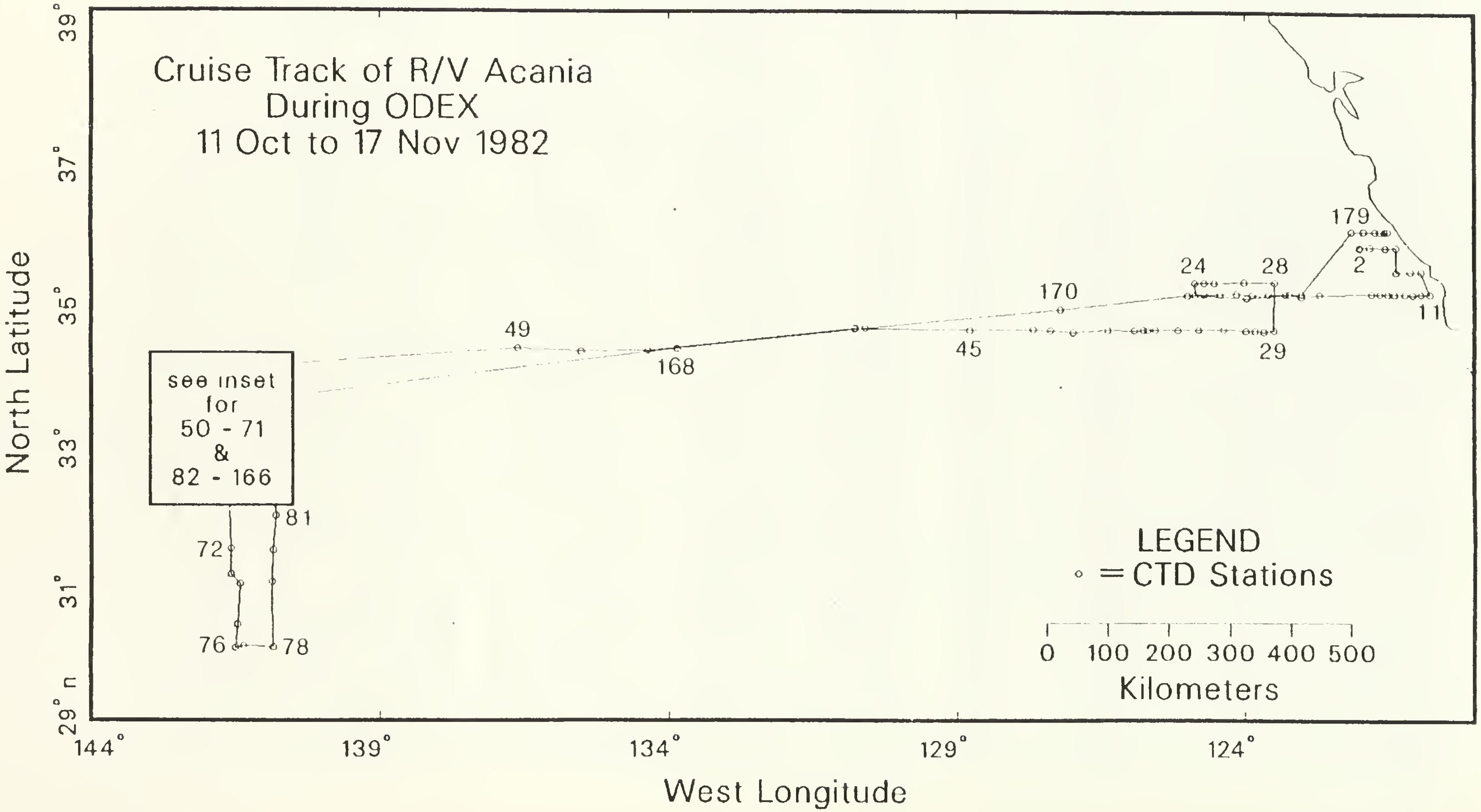
a. California Current water mass T/S envelope characteristic of stations east of approximately 129 W (Station 45 and eastward; see Figure 1).

b. Transition water mass T/S signature found at stations 46, 47 & 48 (Figure 1) between longitudes 129 & 136 W. The transition to the Northern East Central North Pacific water mass (panel c below) occurs abruptly at a sharp salinity front near 136 W (see also Section 4.1).

c. Northern East Central North Pacific (ECNP/N) water mass T/S signature (following nomenclature of Sverdrup et al 1942, and Niiler and Reynolds, 1984). These T/S curves were taken from stations 49 - 52, however the T/S curve associated with the ECNP/N water mass was found at many stations in the inset area (Figures 1 and 2).

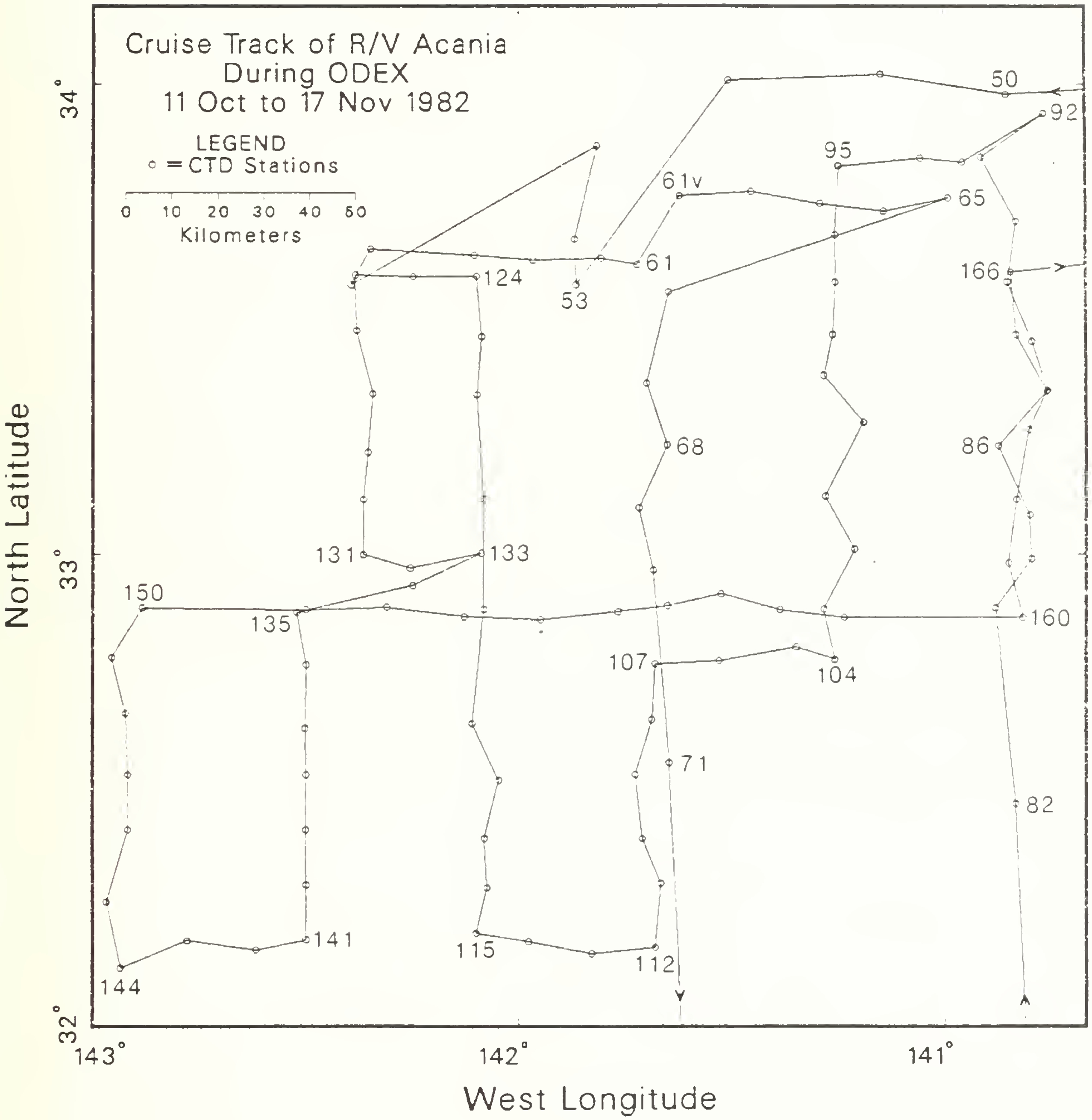
d. Mixed ECNP/N (panel c above) and ECNP/S (panel e below) water mass T/S envelope characteristic of stations in the Sub-Tropical front. See also Meridional Hydrographic Sections (large scale and mesoscale), and cross-front vertical profile comparisons, elsewhere in this report. All stations in the ODEX site (Figure 2) fall within the envelope defined by panels c - e.

e. Southern East Central North Pacific (ECNP/S) water mass T/S signature, showing data from stations 72 - 81. The ECNP/S T/S characteristic was also found at many stations in the inset area illustrated in Fig. 2.



Cruise Track of R/V Acania
During ODEX
11 Oct to 17 Nov 1982
see inset
for
50 - 71
&
82 - 166
49
168
170
45
24
28
29
179
2
11
72
76
78
81
LEGEND
∘ = CTD Stations
0 100 200 300 400 500
Kilometers
39°
37°
35°
33°
31°
29° n
North Latitude
144°
139°
134°
129°
124°
West Longitude

Figure 1



Cruise Track of R/V Acania
During ODEX
11 Oct to 17 Nov 1982
LEGEND
○ = CTD Stations
0 10 20 30 40 50
Kilometers
North Latitude
West Longitude
34°
33°
32°
143°
142°
141°
50
92
95
61v
65
61
53
124
166
68
86
131
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141
115
112
144

Figure 2

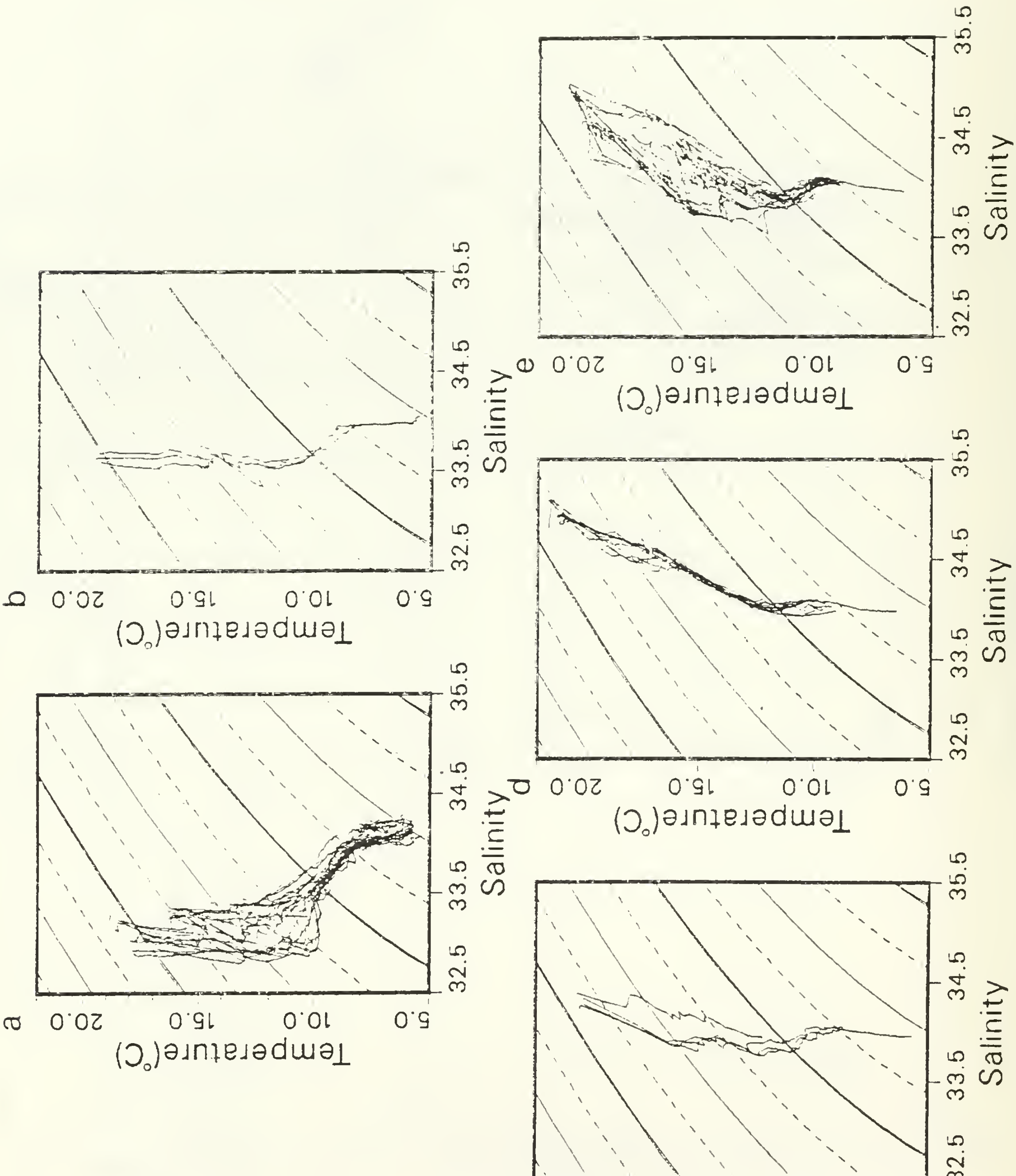


Figure 3

4.1 LARGE SCALE ZONAL HYDROGRAPHIC/OPTICAL SECTIONS NEAR 35 N
Stations 11 - 52 (Figure 1).

The following six figures illustrate zonal vertical structure in Temperature, Salinity, Density (sigma-t), Sound Speed, Beam Attenuation Coefficient c(660 nm), and the Brunt-Vaisala Frequency N respectively. The section extends from the California Coast to 142 W, and from the surface to 300 dbars. There are several noteworthy features in these hydrographic sections.

a. Over the continental shelf (near station 11), isopycnals at depths below 120 m slope down to the east, clearly indicating the presence of a poleward undercurrent.

b. A strong front occurs over the continental slope between 122 & 125 W. In this regime, isopycnals slope down to the west and indicate southward geostrophic flow at all depths.

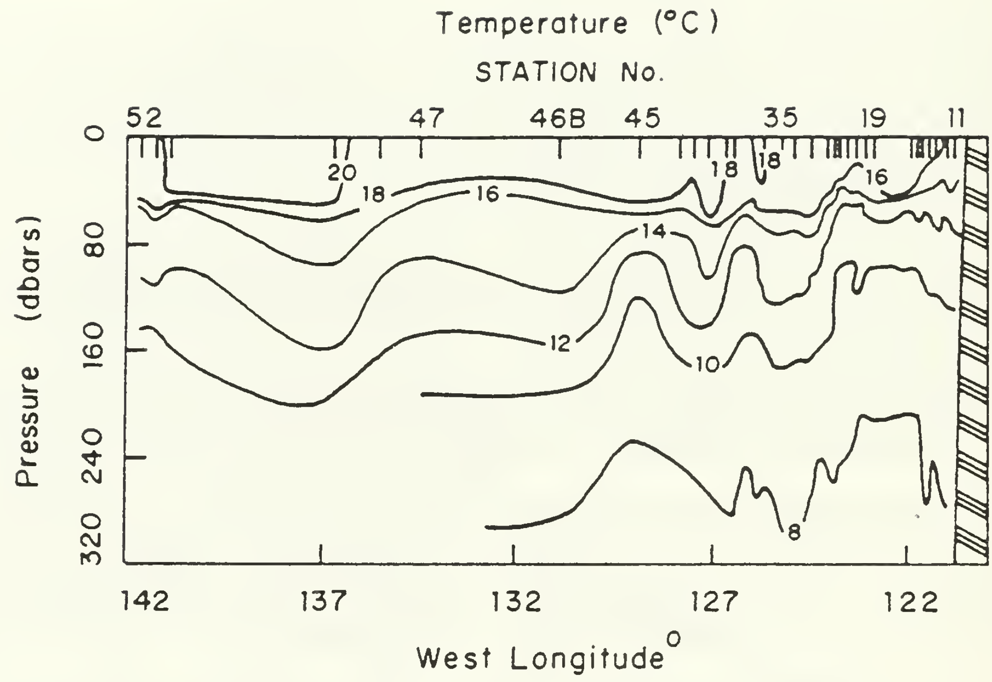
c. A strong eddy-like feature is centered near 129 W (station 45). The surface layer between this eddy signature and the frontal signature beginning at 123 W is characterized by a broad salinity minimum and a weak horizontal temperature gradient with warmer waters to the west.

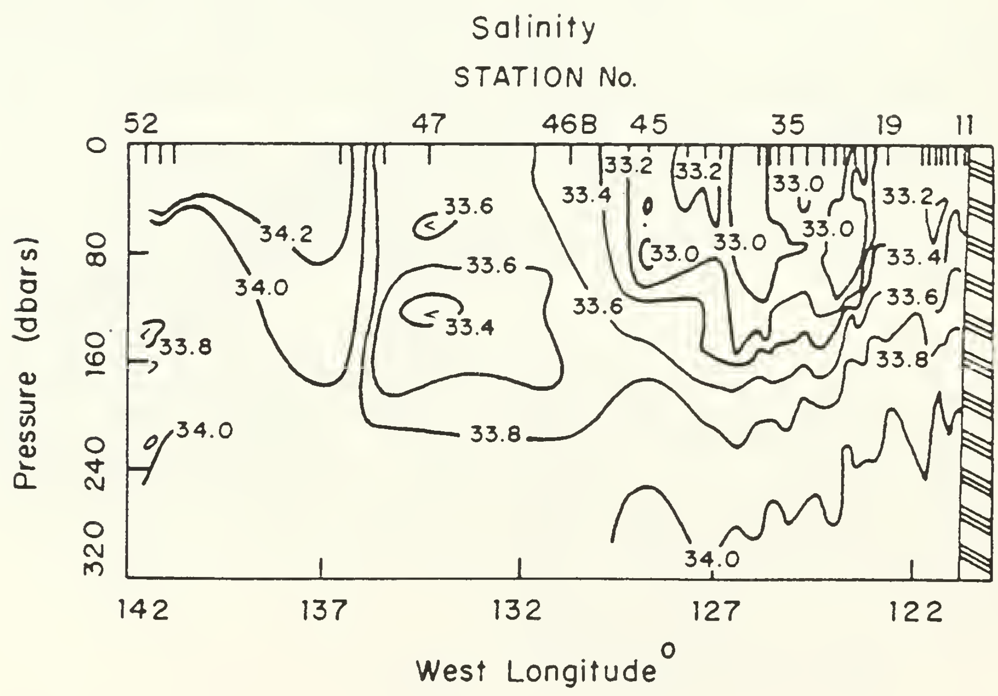
d. The subarctic water mass (Fig. 3b) found immediately to the west of the eddy-like feature near 129 W is bounded on the west by a strong surface-layer salinity front near 136 W.

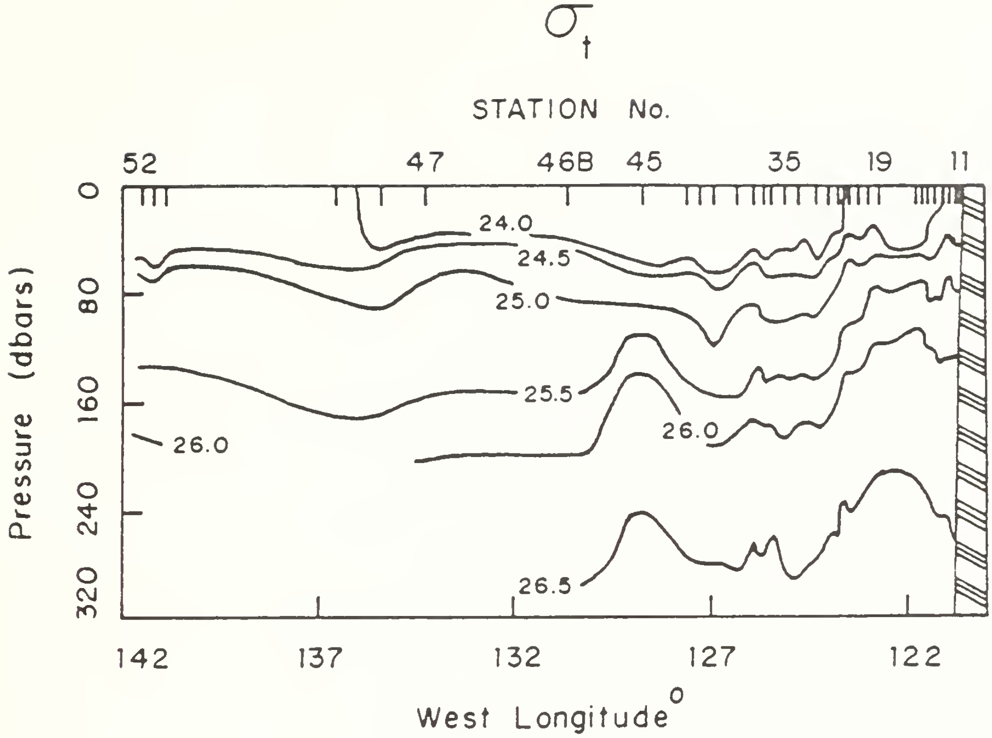
Organized features in the beam attenuation coefficient c(660 nm) section display obvious associations with the hydrographic structure.

a. Extremely high attenuation coefficients (implying high particle concentrations) occur in the poleward undercurrent over the continental shelf; the cluster of c(660) isolines drawn just above the shelf are not labelled, but the maximum value in the core of the undercurrent exceeds 0.7 m^-1.

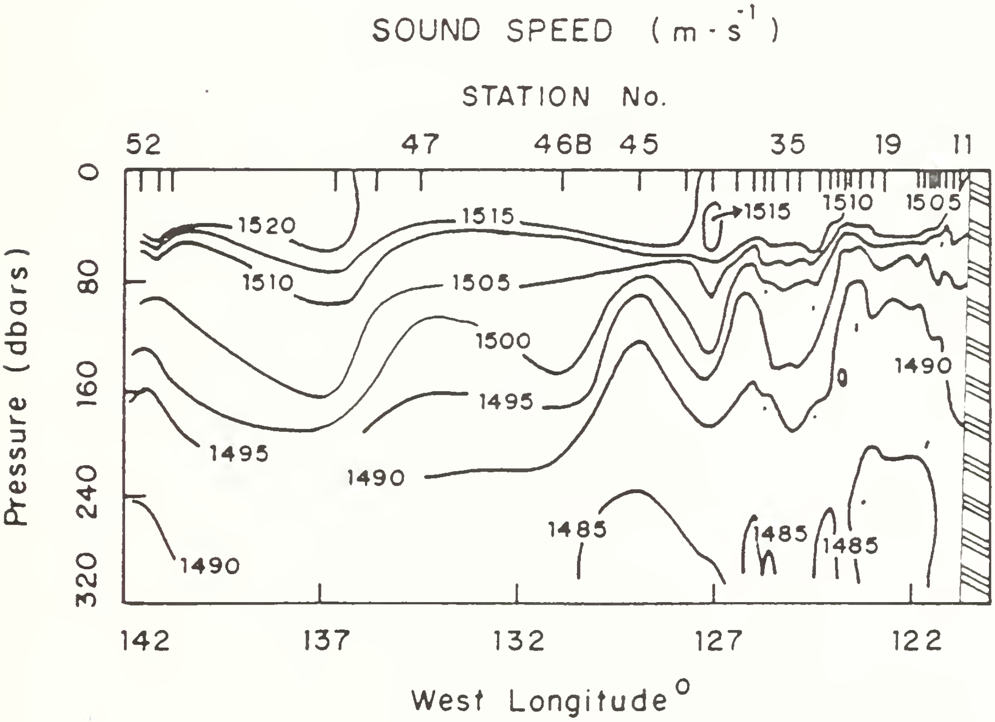
b. Over the continental shelf inshore of 122 W, maximum c(660) values occur in the surface mixed layer (with the exception of the poleward bottom nephloid jet noted above). Between 122W and 125 W however, the c(660) maximum descends to the thermo- cline; this optical front coincides with the density front noted above. A c(660) maximum was found near the top of the seasonal thermocline at all stations to the west of this front.


Temperature (°C)
STATION No.
52
47
46B
45
35
19
11
20
18
16
14
12
10
8
Pressure (dbars)
0
80
160
240
320
142
137
132
127
122
West Longitude°


Salinity
STATION No.
52
47
46B
45
35
19
11
34.2
34.0
33.8
33.6
33.4
33.2
33.0
Pressure (dbars)
0
80
160
240
320
142
137
132
127
122
West Longitude°

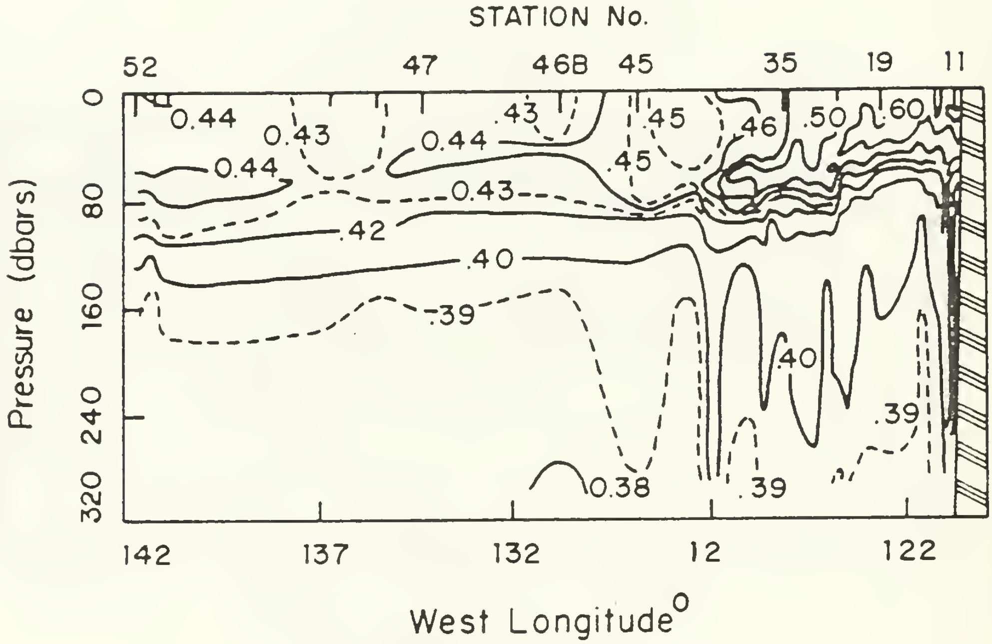


σ_t
STATION No.
52
47
46B
45
35
19
11
24.0
24.5
25.0
25.5
26.0
26.0
26.5
Pressure (dbars)
0
80
160
240
320
142
137
132
127
122
West Longitude°

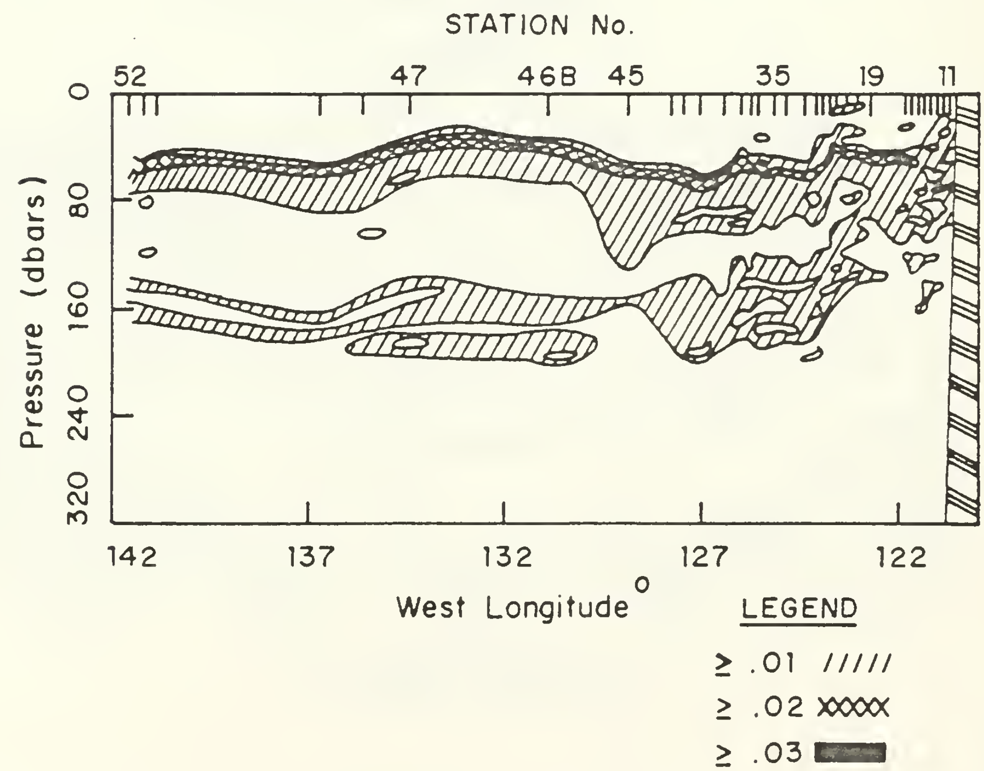


SOUND SPEED (m · s⁻¹)
STATION No.
52
47
46B
45
35
19
11
1520
1515
1515
1510
1505
1510
1505
1500
1495
1495
1490
1490
1490
1485
1485
1485
Pressure (dbars)
0
80
160
240
320
142
137
132
127
122
West Longitude°

BEAM ATTENUATION
COEFFICIENT 660nm (m^{-1})



N (s^{-1})



4.2 LARGE SCALE MERIDIONAL HYDROGRAPHIC SECTIONS NEAR 142 W. Stations 78 - 92 (Figs. 1 & 2) and DeSteiguer Stations 8S-11S

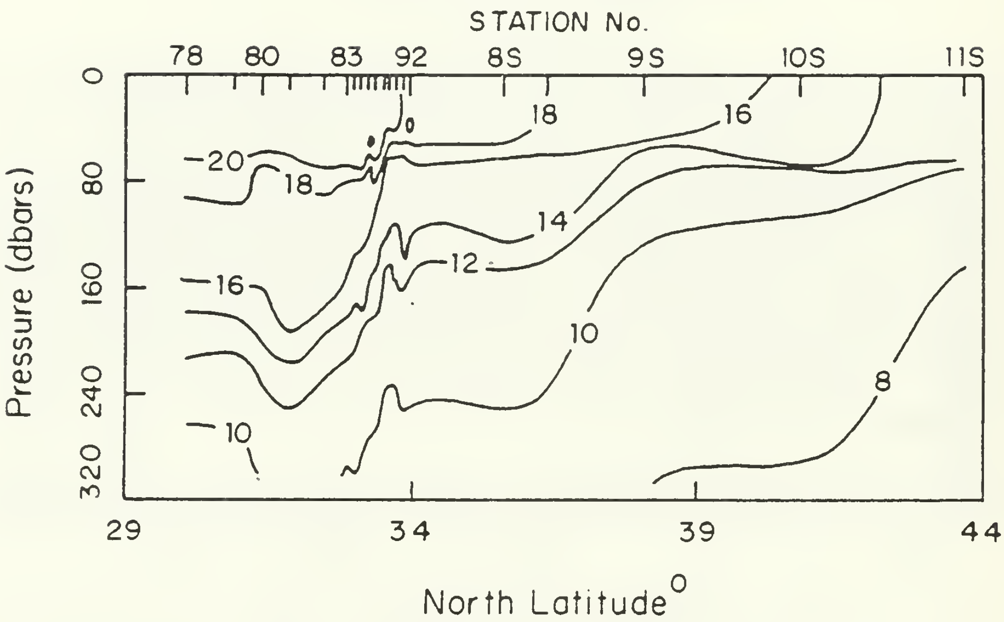
The following 4 figures illustrate vertical meridional structures in Temperature, Salinity, Density (sigma-t) and Sound Speed respectively. The sections are composited from Acania stations 78 through 92 (Figures 1 and 2), and from hydrographic stations occupied during ODEX by the R/V Desteiguer along a line extending approximately from 34N, 141W to 44N, 149W. The DeSteiguer CTD data were kindly provided as a courtesy by R. Austin (SIO, Visibility Lab, San Diego, CA; personal communication).

Two major ocean fronts dominate these hydrographic sections: the Sub-Tropical Ocean Front near 33N and the Sub-Arctic Ocean Front near 40 N.

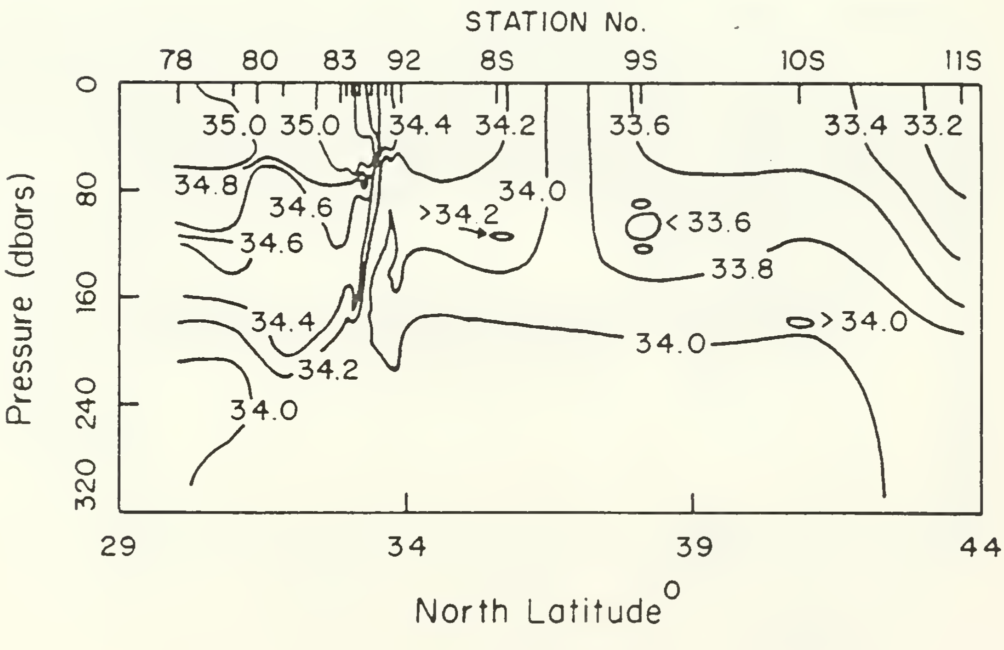
The Subarctic Front appears as a density front predominately in the surface layer with denser water to the north. The horizontal density gradient in this front is produced primarily by the surface layer meridional temperature gradient.

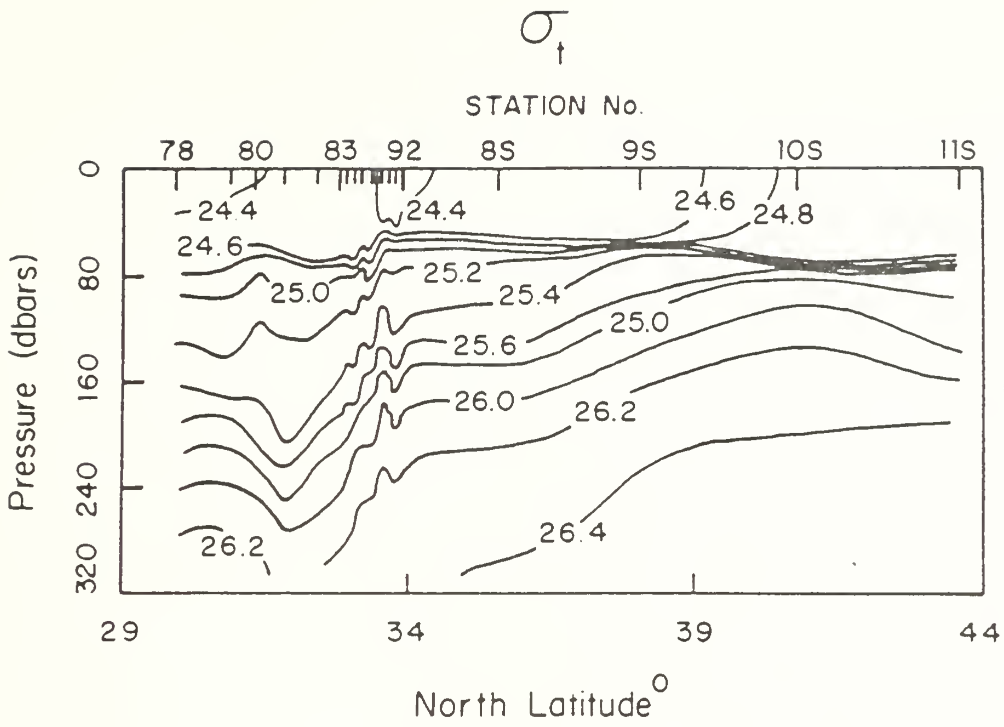
The Subtropical Front, on the other hand, is characterized by density gradients only at depths beneath 50 m, and with significant density gradients extending deeper than the 300 m limit of these sections. A significant meridional gradient in salinity occurs in the surface mixed layer (above 50 m), but its effect on density is compensated by the meridional gradient in surface layer temperature.

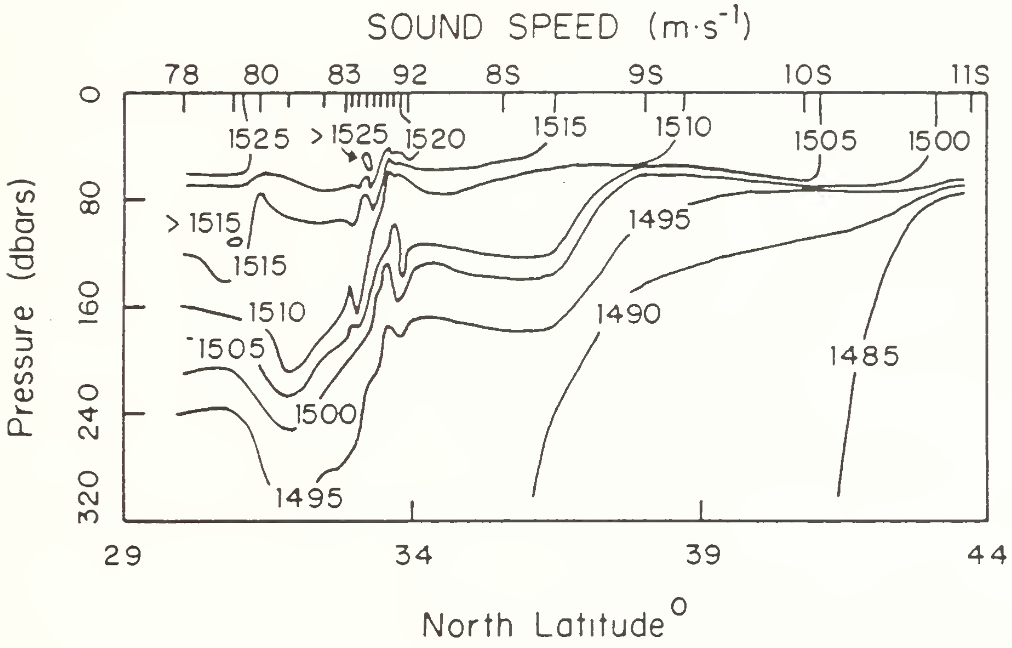
TEMPERATURE (°C)



SALINITY

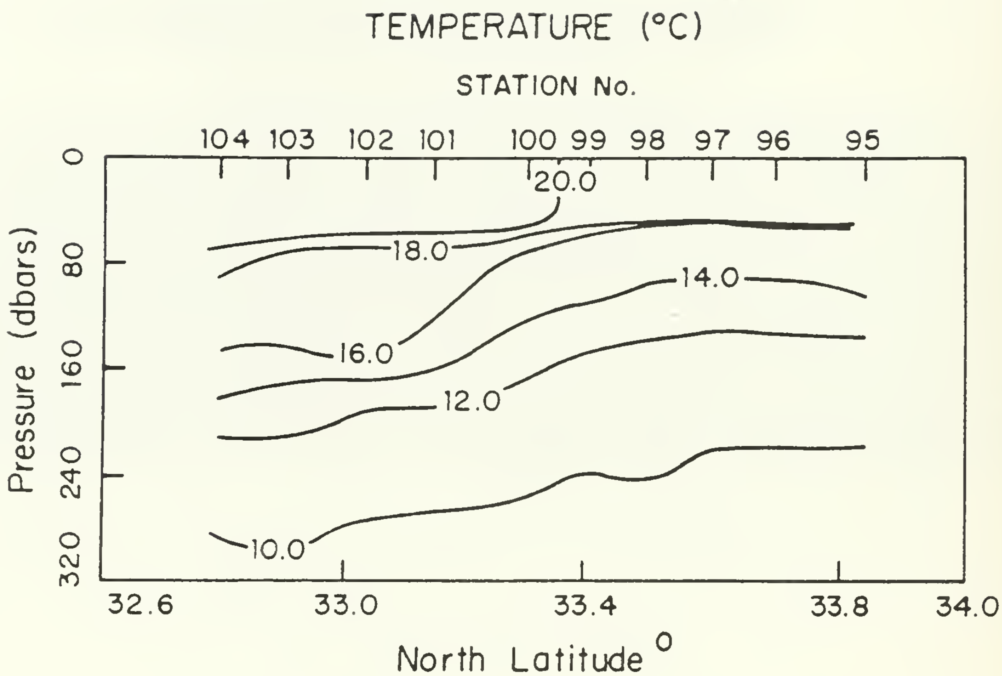


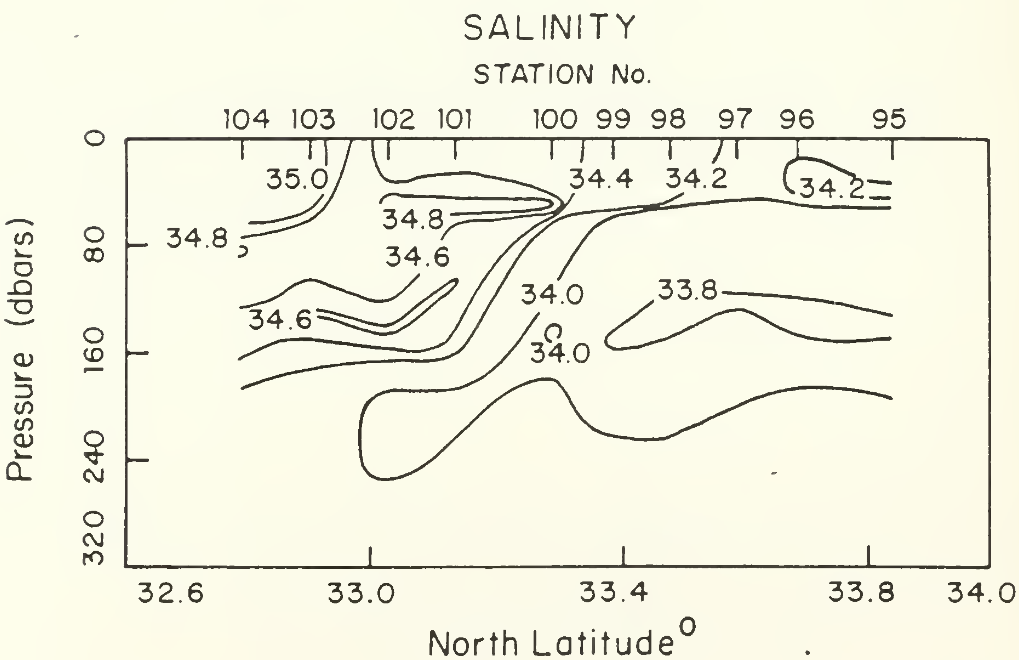

σ_t
STATION No.
78 80 83 92 8S 9S 10S 11S
24.4
24.4
24.6
24.8
24.6
25.2
25.0
25.4
25.0
25.6
26.0
26.2
26.4
26.2
Pressure (dbars)
0 80 160 240 320
29 34 39 44
North Latitude°

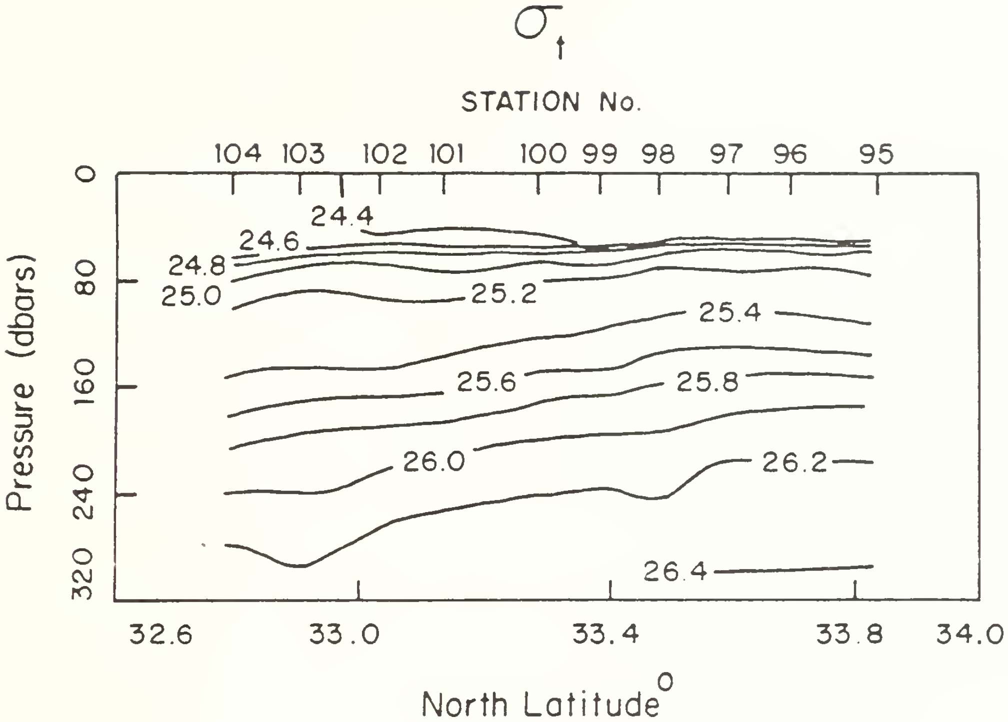

SOUND SPEED ($m \cdot s^{-1}$)
78 80 83 92 8S 9S 10S 11S
1525
>1525
1520
1515
1510
1505
1500
>1515
1515
1495
1510
1490
1505
1485
1500
1495
Pressure (dbars)
0 80 160 240 320
29 34 39 44
North Latitude°

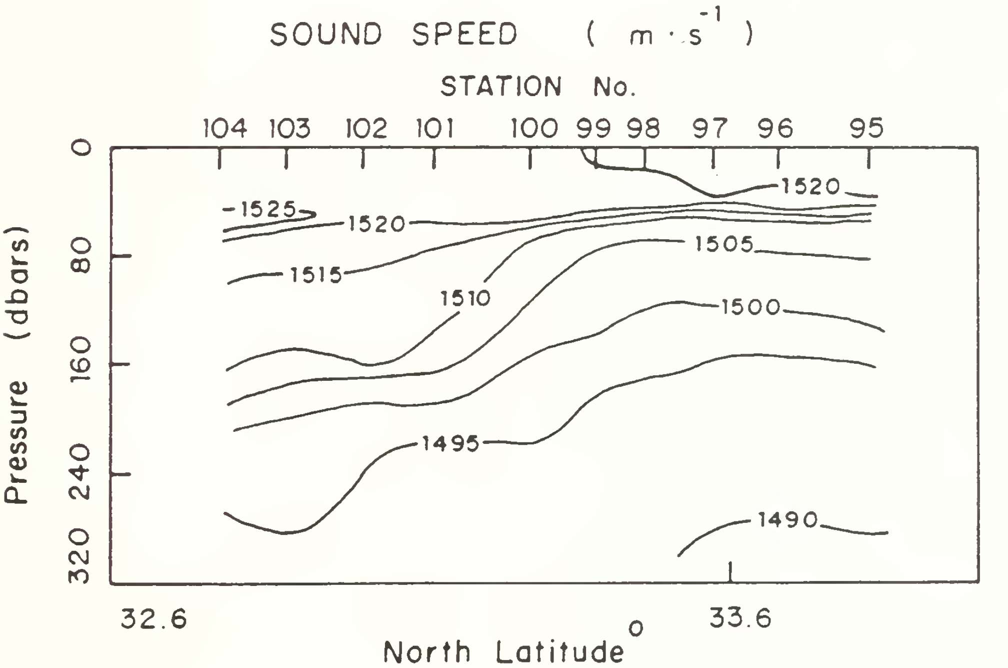
4.3 MESOSCALE HYDROGRAPHIC AND OPTICAL SECTIONS ACROSS THE SUBTROPICAL FRONT NEAR 141W Stations 95 - 104 (Figure 2)

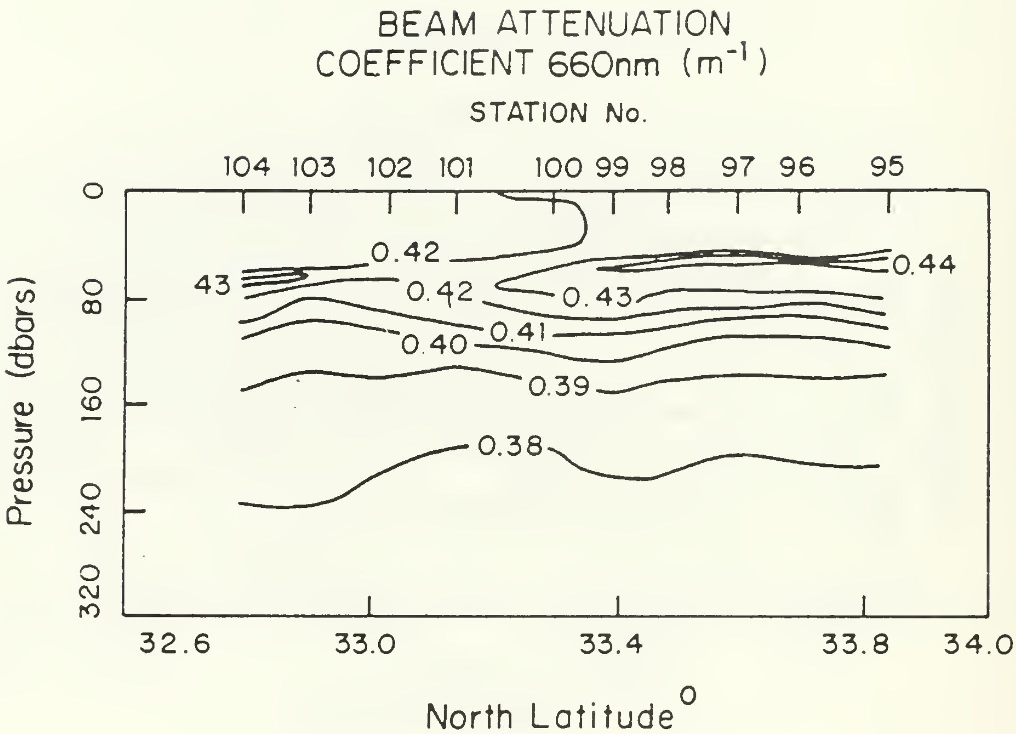
The following six figures illustrate vertical meridional structure across the Sub-Tropical Front near 141W in Temperature, Salinity, Density (sigma-t), Sound Speed, Beam Attenuation c(660 nm), and Brunt- Vaisala Frequency N respectively. In terms of density, the horizontal gradient associated with the front is confined primarily beneath the surface mixed layer (50 m and deeper). The pycnocline and thermocline are shallower and stronger north of the front than to the south. Pronounced horizontal gradients and interleaving in the surface mixed layer and upper thermocline salinity are partially compensated by the associated temperature gradients, thus producing relatively weak horizontal density gradients at these depths.

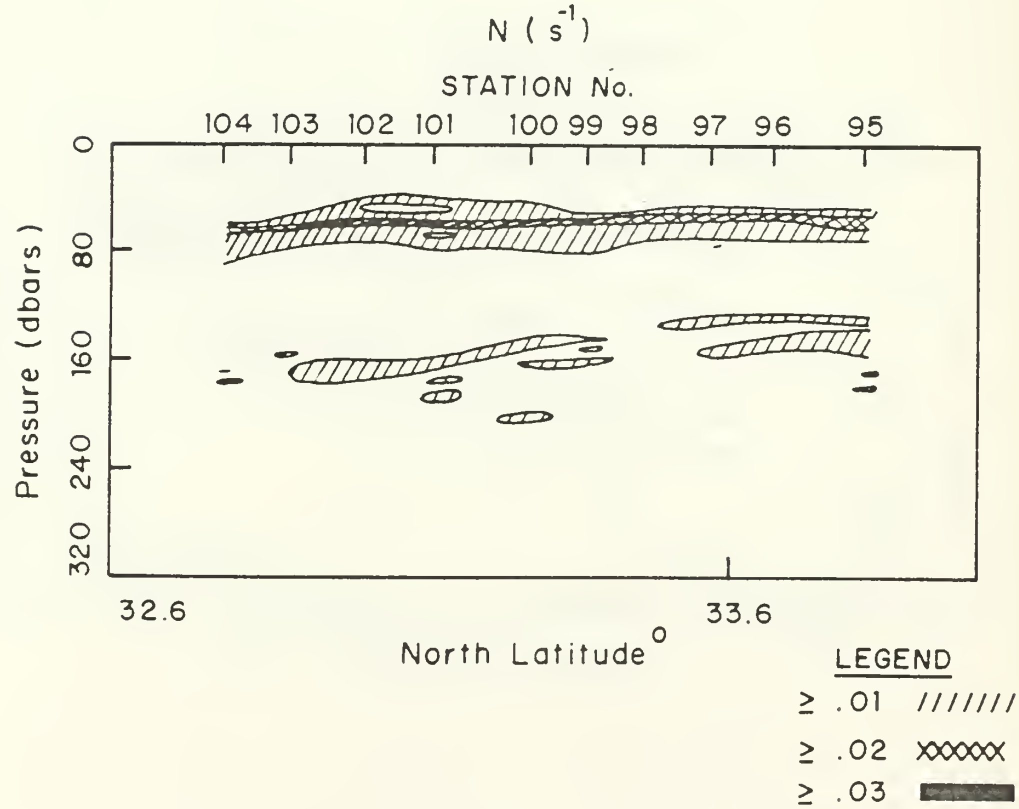

TEMPERATURE (°C)
STATION No.
104 103 102 101 100 99 98 97 96 95
20.0
18.0
16.0
14.0
12.0
10.0
Pressure (dbars)
0
80
160
240
320
32.6
33.0
33.4
33.8
34.0
North Latitude °


SALINITY
STATION No.
104 103 102 101 100 99 98 97 96 95
35.0
34.8
34.8
34.6
34.6
34.4
34.2
34.2
34.0
34.0
33.8
Pressure (dbars)
0
80
160
240
320
32.6
33.0
33.4
33.8
34.0
North Latitude °


σt
STATION No.
104 103 102 101 100 99 98 97 96 95
24.4
24.6
24.8
25.0
25.2
25.4
25.6
25.8
26.0
26.2
26.4
0
80
160
240
320
Pressure (dbars)
32.6
33.0
33.4
33.8
34.0
North Latitude°


SOUND SPEED (m · s⁻¹)
STATION No.
104 103 102 101 100 99 98 97 96 95
1525
1520
1520
1515
1510
1505
1500
1495
1490
0
80
160
240
320
Pressure (dbars)
32.6
33.6
North Latitude°


BEAM ATTENUATION
COEFFICIENT 660nm (m-1)
STATION No.
104 103 102 101 100 99 98 97 96 95
0.42
43
0.42
0.43
0.44
0.41
0.40
0.39
0.38
Pressure (dbars)
0
80
160
240
320
32.6
33.0
33.4
33.8
34.0
North Latitude°

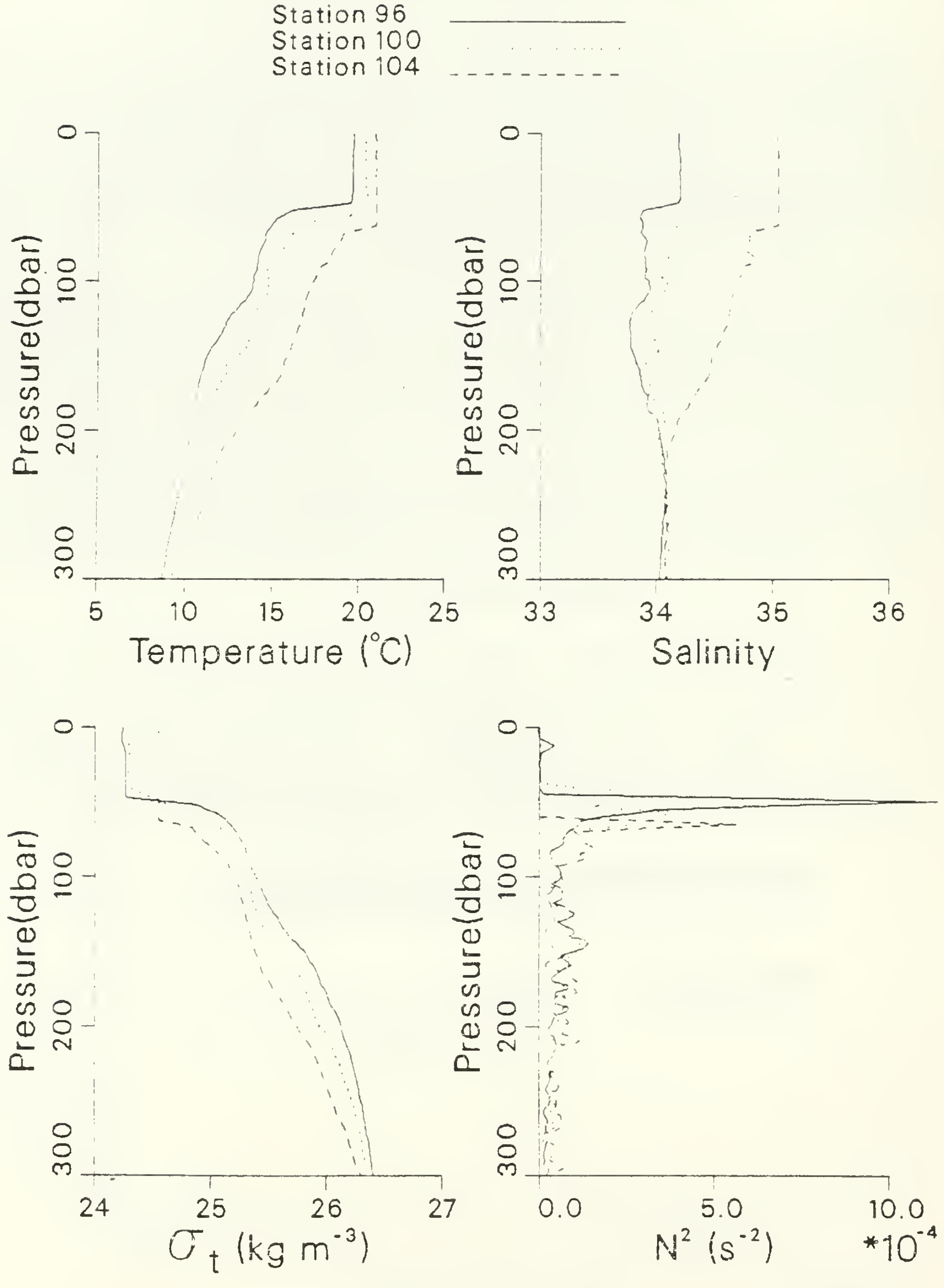

N (s-1)
STATION No.
104 103 102 101 100 99 98 97 96 95
Pressure (dbars)
0
80
160
240
320
32.6
33.6
North Latitude°
LEGEND
≥ .01 ///////
≥ .02 XXXXXX
≥ .03

4.4 COMPARISON OF HYDROGRAPHIC AND OPTICAL PROFILES ACROSS THE SUBTROPICAL FRONT NEAR 141W
Stations 96, 100 & 104 (Figure 2)

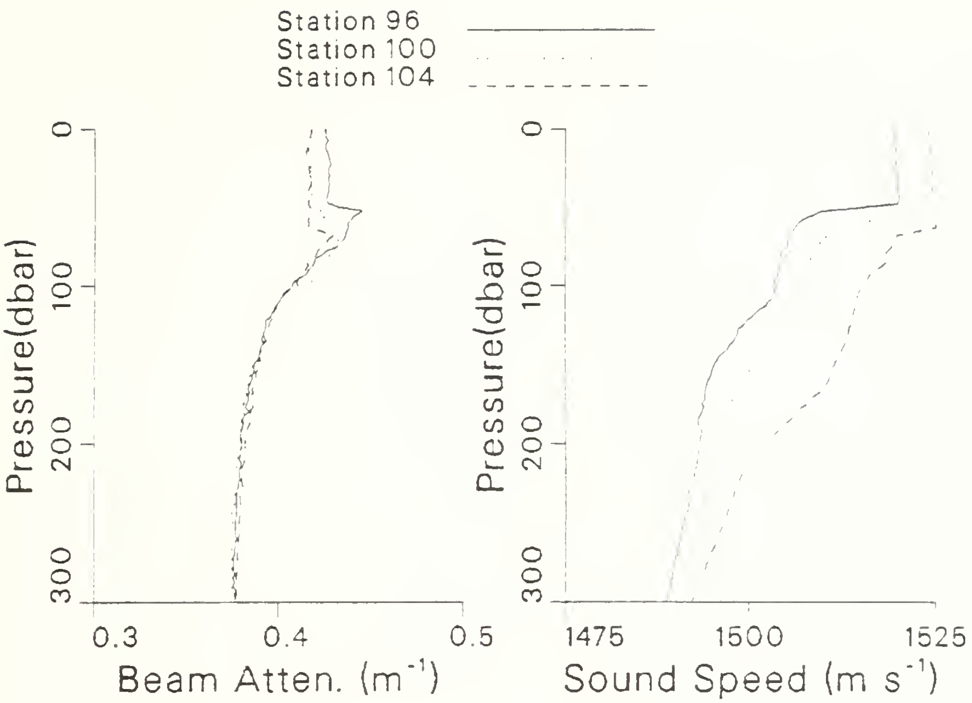
The following six panels compare vertical profiles of hydrographic variables and c(660) at 3 of the stations used to plot the vertical sections illustrated in the previous section. Station 96 lies to the north of the Subtropical Front in an ECNP/N water mass, station 104 lies south of the front in ECNP/S water, and the mixed characteristics of the station 100 profiles reveal it to be within the frontal mixing zone itself.

The strong salinity inversion, which is partially compensated by an accompanying (but weak) temperature inversion, occurs at station 100 near a depth of 50 m. The signature of interleaving of ECNP/N & ECNP/S water masses at the depth of the shallower thermocline associated with the ECNP/N water mass occured commonly at stations within the subtropical front itself. It is interesting that, in this example at least, the intrusion of ECNP/S water produces a shallower mixed layer (as defined by the top of seasonal pycnocline, taken as the depth where N^2 first exceeds 10^{-4}) in the frontal zone (station 100) than occurs at either stations 96 or 104.

Station 96 displays a very weak pycnocline ($5 \times 10^{-5} < N^2 < 10^{-4}$) near a depth of 15 m. A shallow mixed layer above the lower N^2 threshold occured at several stations in the region, leading us to consider two mixed layer depths: a "surface mixed layer" with $N^2 < 5 \times 10^{-5}$, and a "primary surface mixed layer" wherein $N^2 < 10^{-4}$. Thus, there are two horizontal maps of mixed layer depths (Section 4.8).



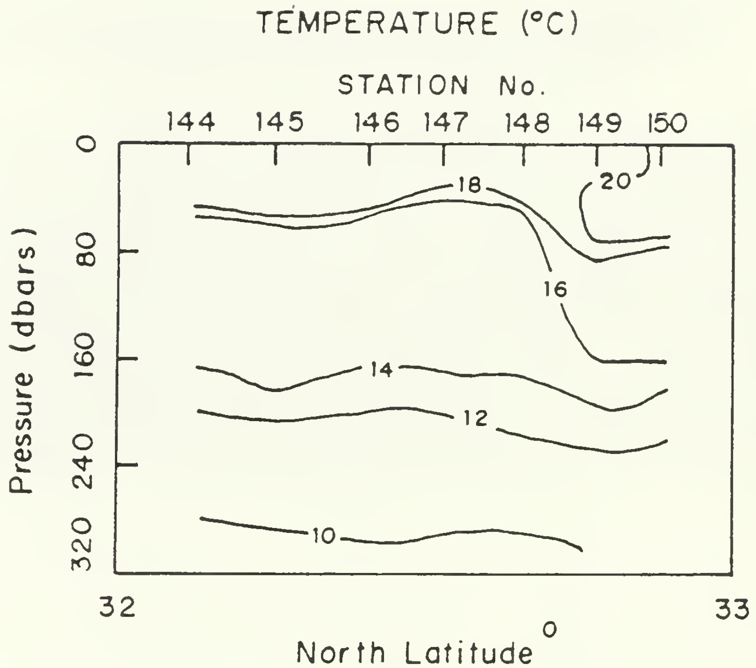
Station 96
Station 100
Station 104
Pressure(dbar)
0
100
200
300
5
10
15
20
25
Temperature (°C)
33
34
35
36
Salinity
24
25
26
27
σ_t (kg m^{-3})
0.0
5.0
10.0
N^2 (s^{-2}) *10^{-4}

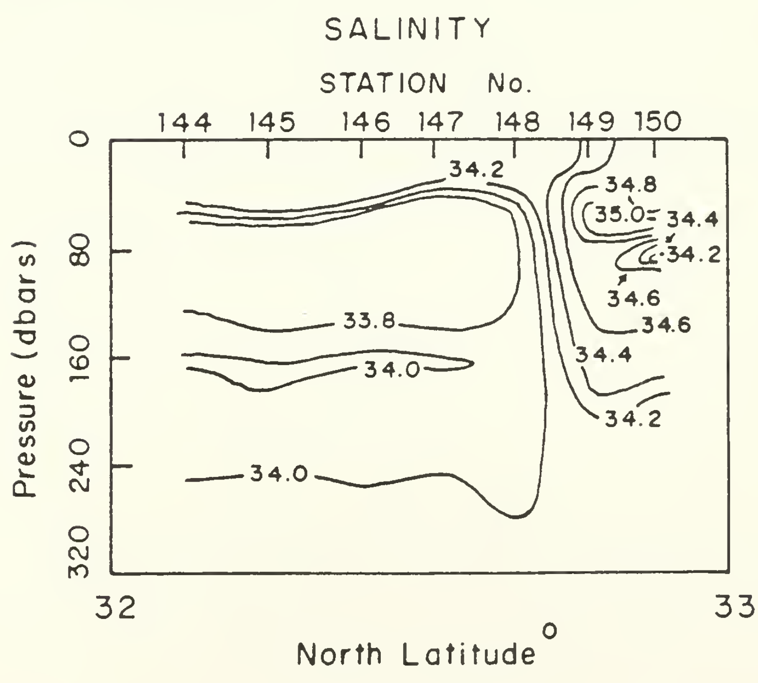


Station 96
Station 100
Station 104
Pressure(dbar)
0
100
200
300
0.3
0.4
0.5
Beam Atten. (m⁻¹)
Pressure(dbar)
0
100
200
300
1475
1500
1525
Sound Speed (m s⁻¹)

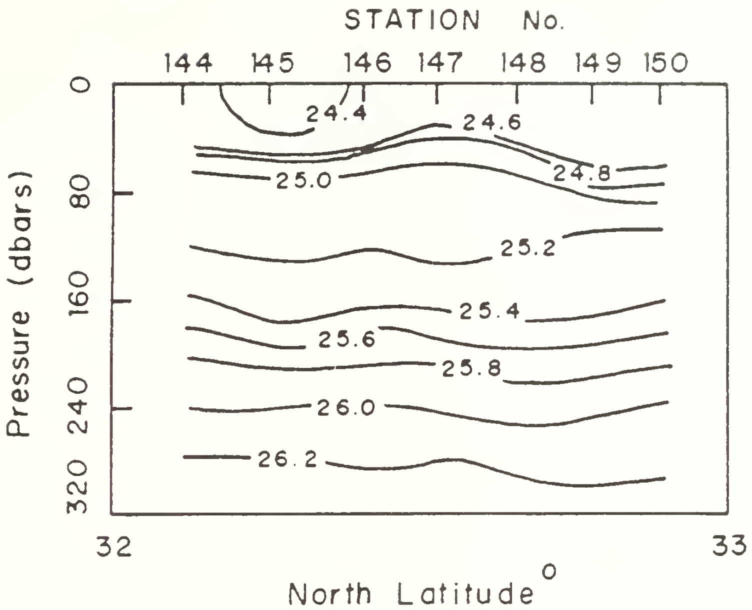
4.5 MESOSCALE HYDROGRAPHIC AND OPTICAL SECTIONS ACROSS THE SUBTROPICAL FRONT NEAR 143W Stations 144 - 150 (Figure 2)

The following panels illustrate distributions of hydrographic variables, c(660), and dissolved oxygen in another vertical section across the Subtropical Front. It is critical to note that in this section the ECNP/S water mass lies to the north of the front, and ECNP/N water lies to the south of the front; examine the horizontal maps of hydrographic and optical variables, and dynamic topography in the subsequent two sets of figures to orient this section relative to the front. As in the sections illustrated in Section 4.3, horizontal gradients in temperature and salinity partially compensate eash other and combine to produce relatively weak (but nevertheless significant) horizontal gradients in density.

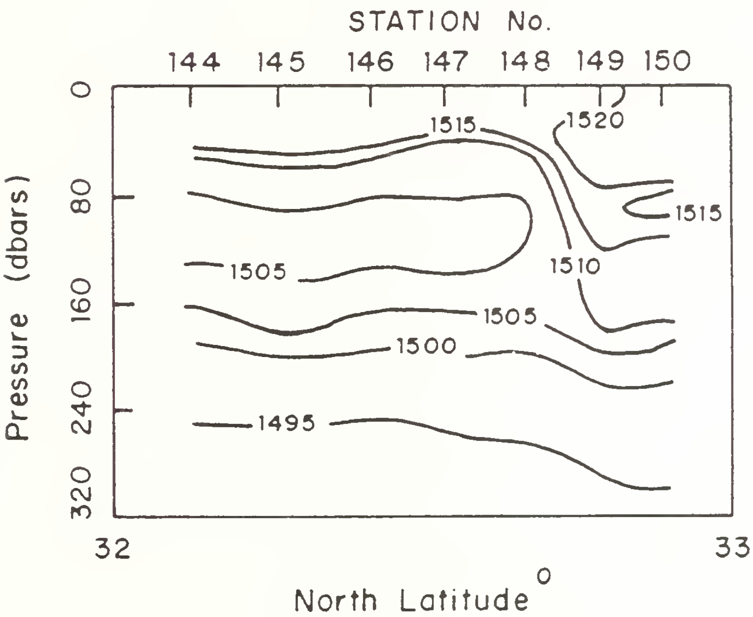

TEMPERATURE (°C)
STATION No.
144 145 146 147 148 149 150
Pressure (dbars)
0
80
160
240
320
20
18
16
14
12
10
32
33
North Latitude °

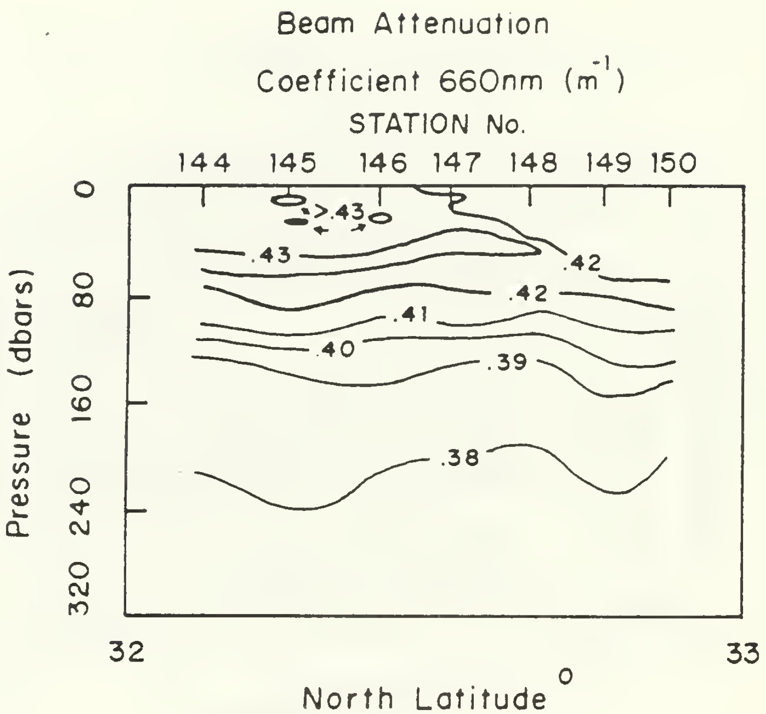

SALINITY
STATION No.
144 145 146 147 148 149 150
Pressure (dbars)
0
80
160
240
320
34.2
34.8
35.0
34.4
34.2
34.6
34.6
33.8
34.4
34.0
34.2
34.0
32
33
North Latitude °

σ_t

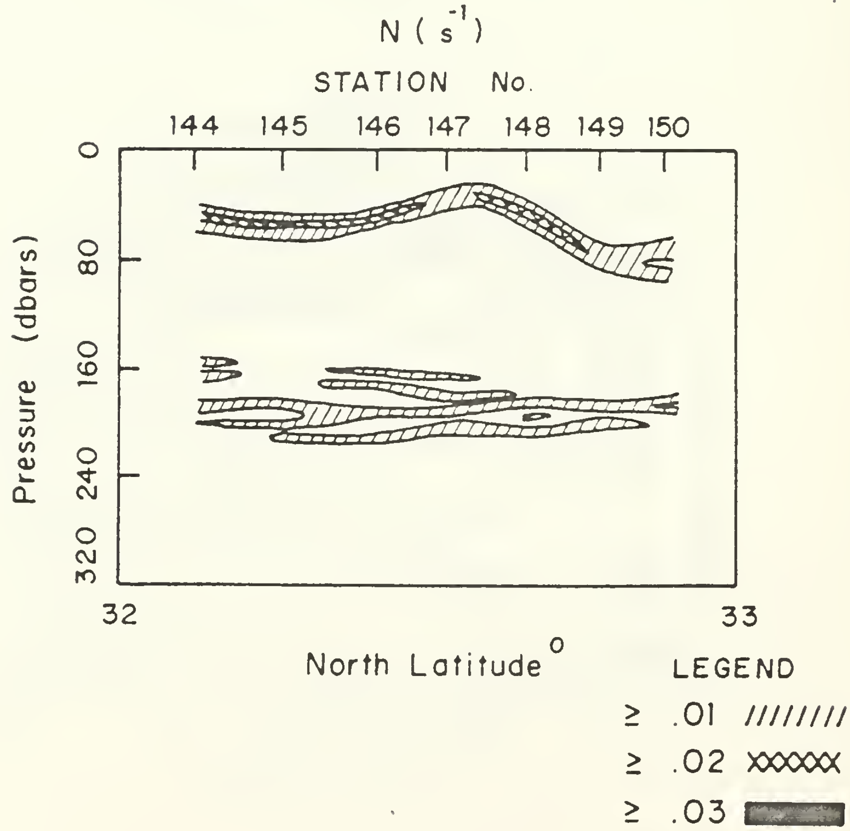


Sound Speed $(m \cdot s^{-1})$

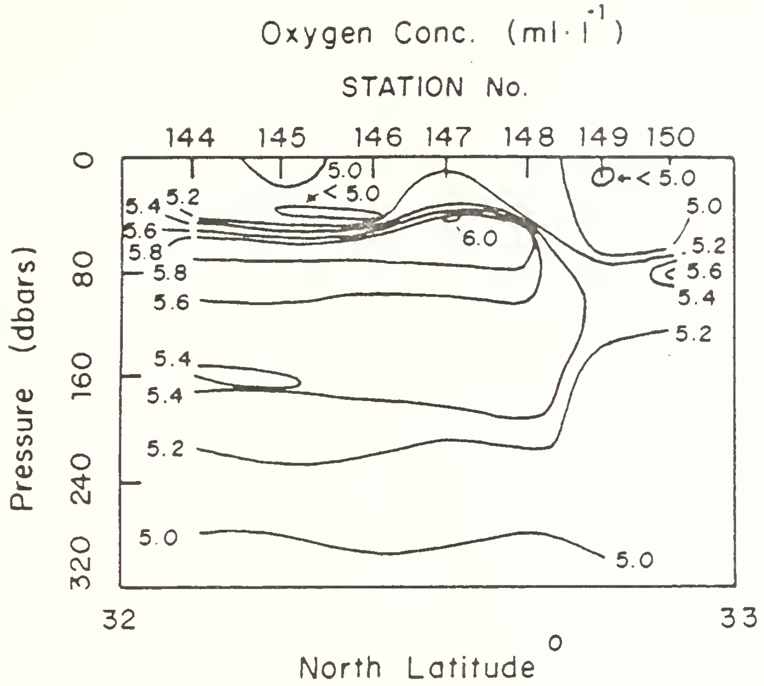




Beam Attenuation
Coefficient 660nm (m^{-1})
STATION No.
144 145 146 147 148 149 150
>.43
.43
.42
.42
.41
.40
.39
.38
0
80
160
240
320
Pressure (dbars)
32
33
North Latitude °



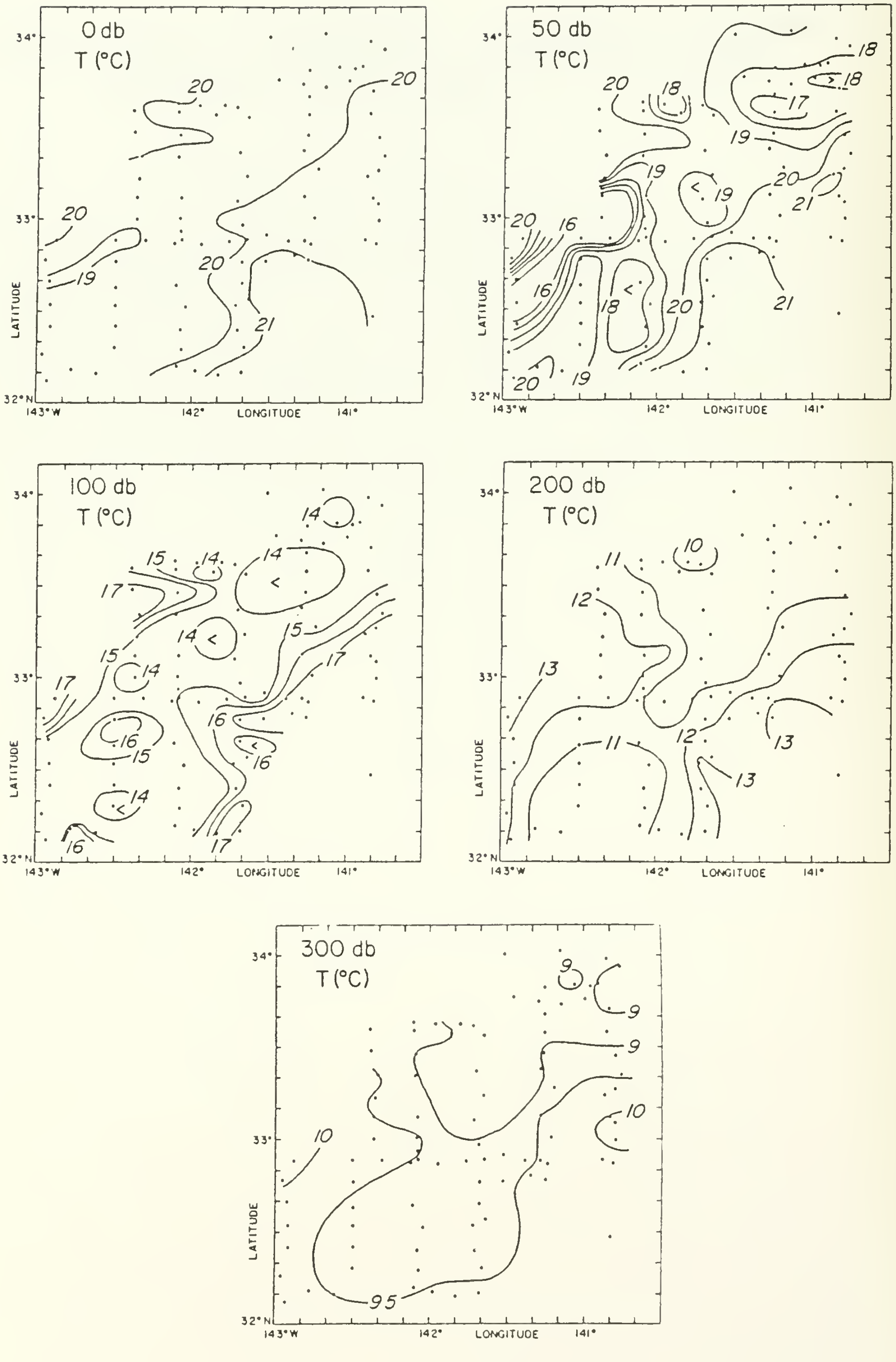
N (s^{-1})
STATION No.
144 145 146 147 148 149 150
0
80
160
240
320
Pressure (dbars)
32
33
North Latitude °
LEGEND
≥ .01
≥ .02
≥ .03

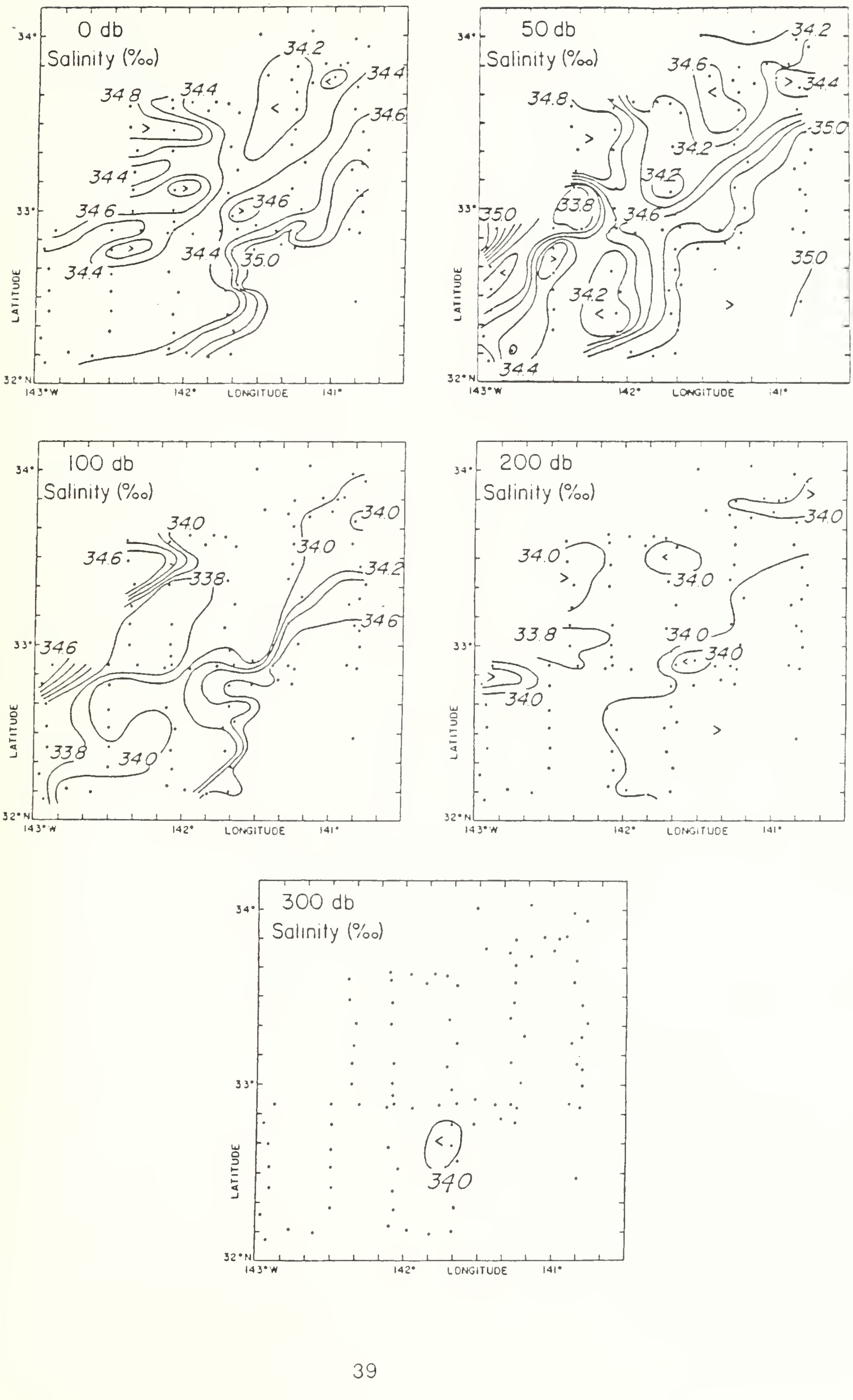


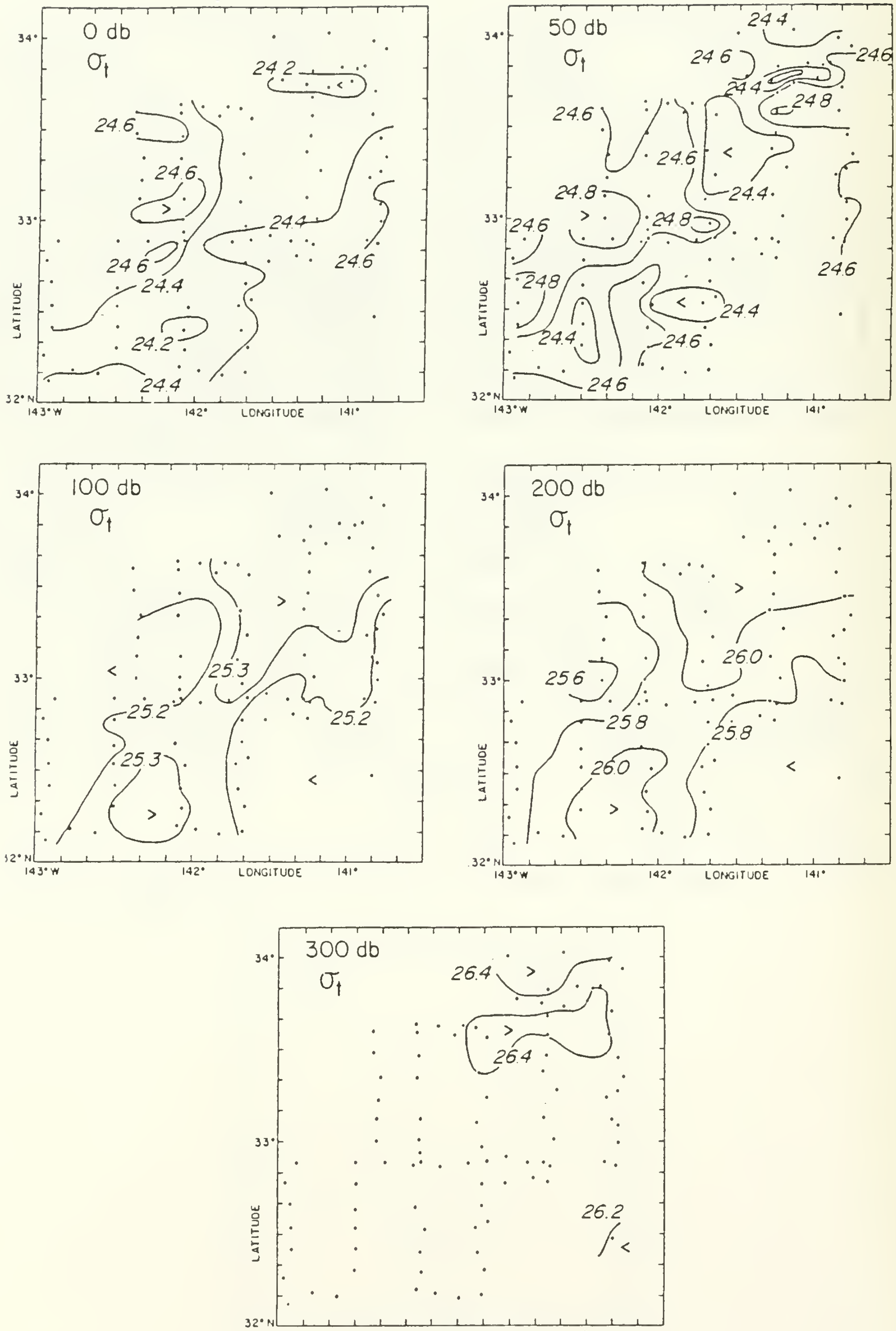
Oxygen Conc. (ml·l⁻¹)
STATION No.
144 145 146 147 148 149 150
5.0
< 5.0
< 5.0
5.0
5.4
5.2
5.6
5.8
6.0
5.2
5.6
5.4
5.8
5.6
5.4
5.2
5.4
5.2
5.0
5.0
Pressure (dbars)
0
80
160
240
320
32
33
North Latitude °

4.6 HORIZONTAL HYDROGRAPHIC DISTRIBUTIONS in the ODEX SITE

Temperature, salinity, and density (sigma-t)
at depths of 0, 50, 100, 200 and 200 decibars

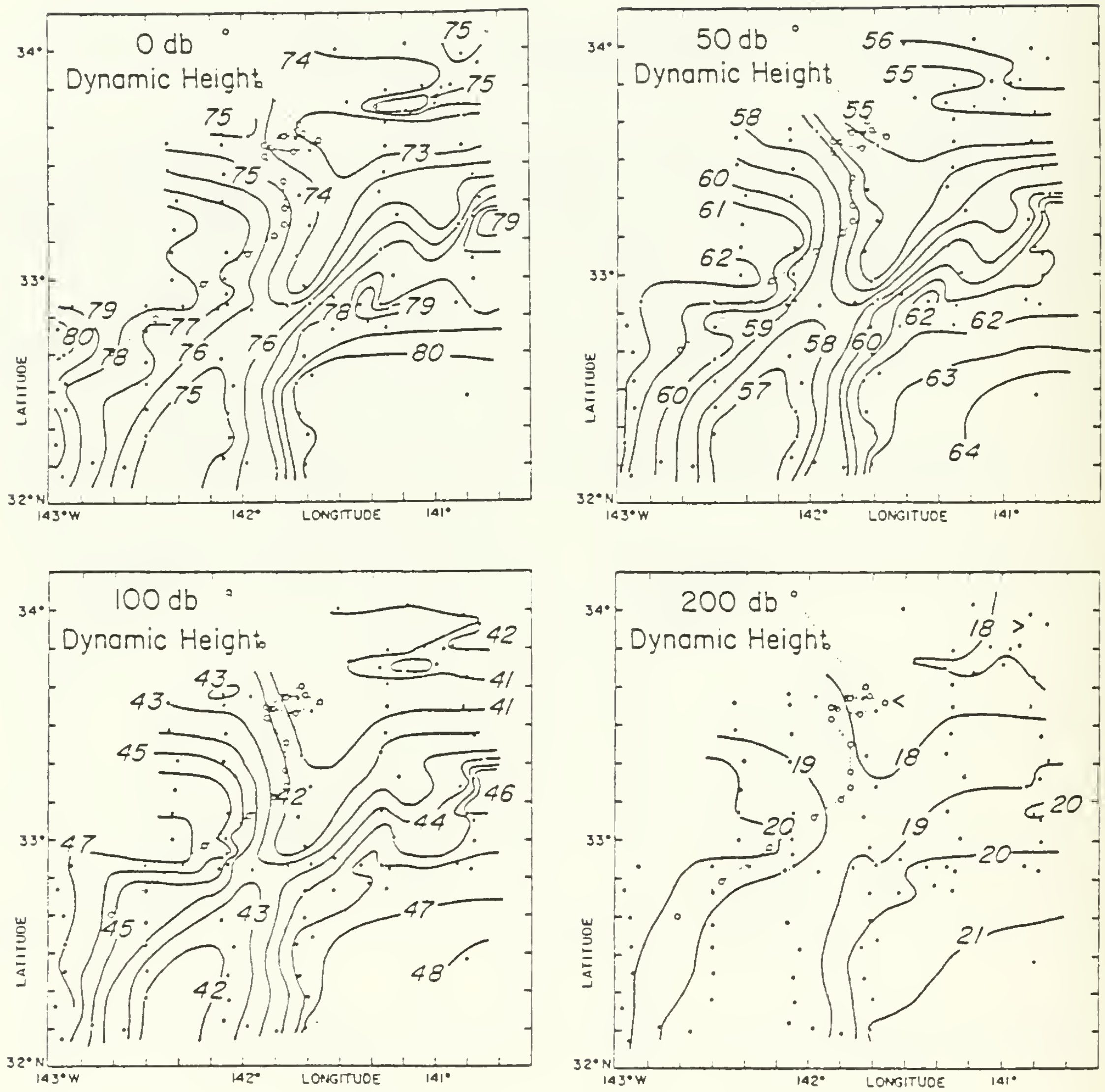

0 db
T (°C)
50 db
T (°C)
100 db
T (°C)
200 db
T (°C)
300 db
T (°C)
34°
33°
32°N
143°W
142°
141°
LONGITUDE
LATITUDE


0 db
Salinity (‰)
34.2
34.4
34.8
34.6
35.0
50 db
33.8
100 db
34.0
33.8
200 db
300 db
LATITUDE
LONGITUDE
34°
33°
32°N
143°W
142°
141°


0 db
σ_t
24.2
24.6
24.6
24.4
24.6
24.6
24.4
24.2
24.4
50 db
σ_t
24.4
24.6
24.6
24.4
24.8
24.6
24.6
24.4
24.8
24.8
24.6
24.6
24.8
24.4
24.4
24.6
24.6
100 db
σ_t
25.3
25.2
25.2
25.3
200 db
σ_t
26.0
25.6
25.8
25.8
26.0
300 db
σ_t
26.4
26.4
26.2
34°
33°
32° N
LATITUDE
143° W
142°
141°
LONGITUDE

4.7 DYNAMIC TOPOGRAPHY in the ODEX SITE
0, 50, 100, and 200 dbars relative to 300 dbars

Dynamic heights are contoured in dynamic cm. The circles connected by dashed lines represent the drift trajectory followed by Flip, commencing near 34 N, 142 W on 23 October 1982 and ending near 32-40 N, 142-40 W on 10 November 1985; the circles represent positions at 1200 GMT.


0 db
Dynamic Height
50 db
Dynamic Height
100 db
Dynamic Height
200 db
Dynamic Height
LATITUDE
LONGITUDE
34°
33°
32°N
143°W
142°
141°

4.8 HORIZONTAL DISTIBUTIONS in the ODEX SITE

a. Surface Mixed Layer Depth ($N^2 < 5 \times 10^{-5}$).

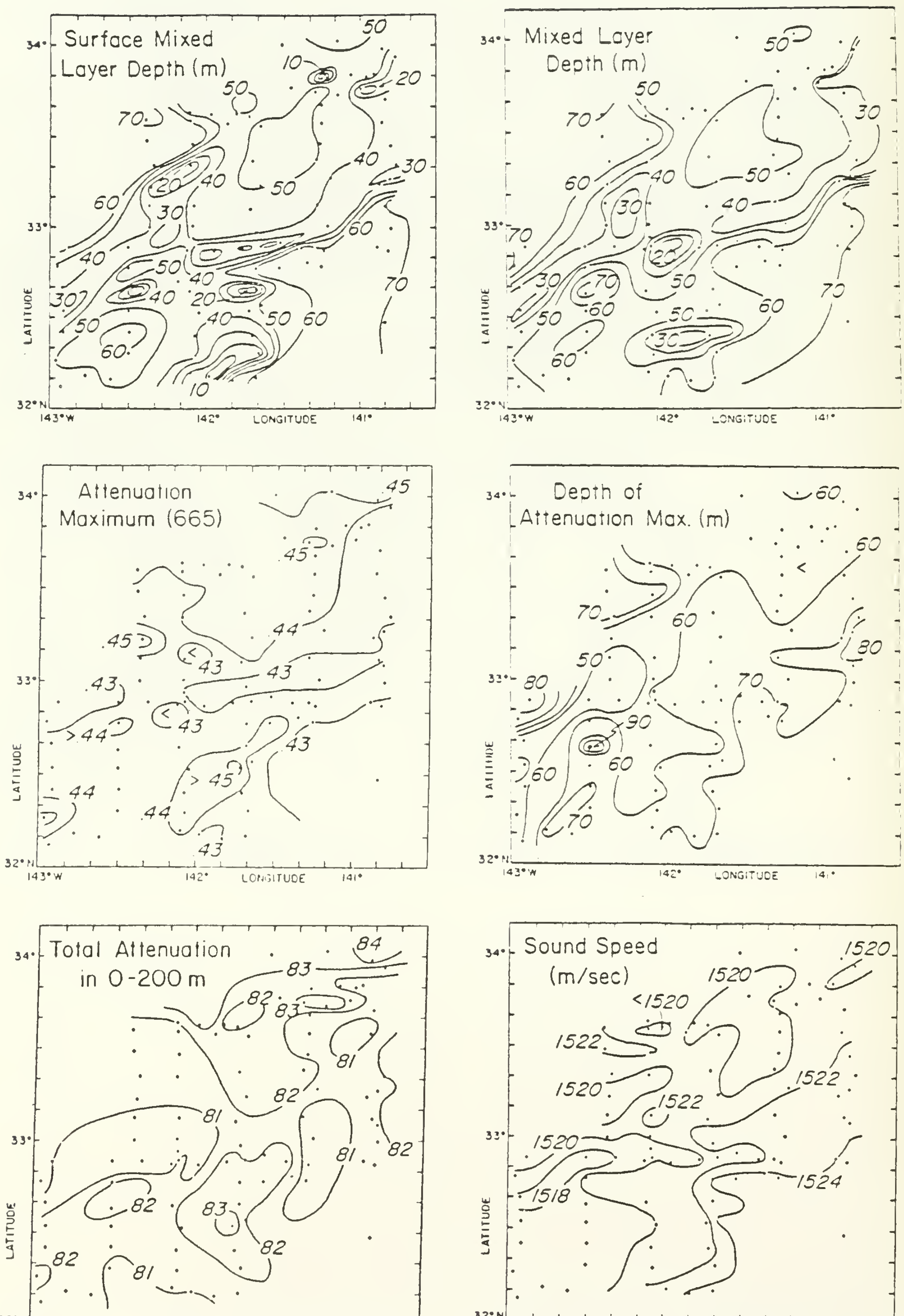
b. Mixed Layer Depth above the "main" seasonal thermocline ($N^2 < 10^{-4}$).

c. Beam Attenuation c(665) Maximum (m^{-1}).

d. Depth of Maximum Beam Attenuation Coefficient.

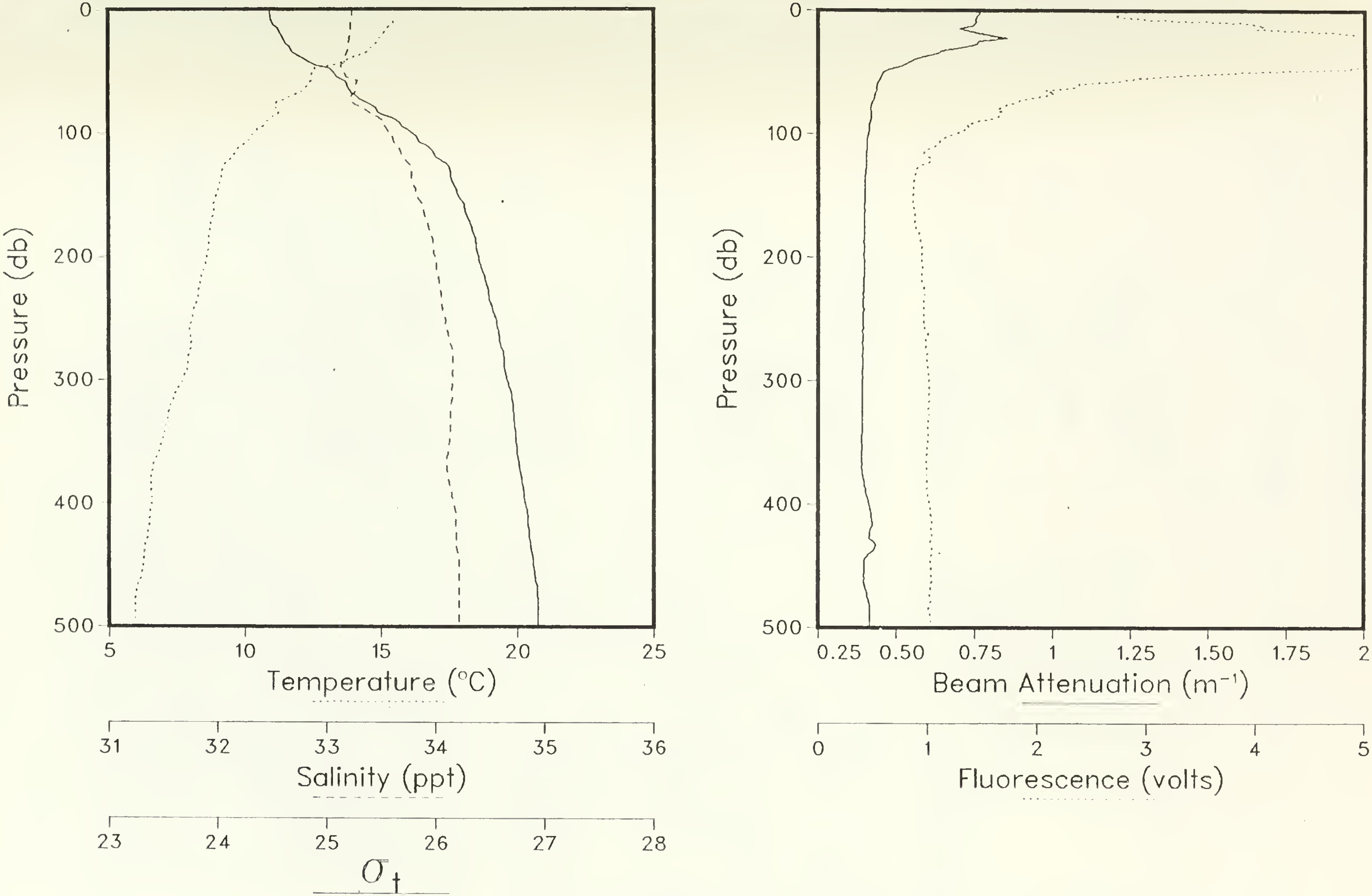
e. Vertically Inegrated Beam Attenuation (particle volume) from 0 to 200 m.

f. Sea Surface Sound Speed (m/sec).


Surface Mixed Layer Depth (m)
Mixed Layer Depth (m)
Attenuation Maximum (665)
Depth of Attenuation Max. (m)
Total Attenuation in 0-200 m
Sound Speed (m/sec)
LATITUDE
LONGITUDE
34°
33°
32°N
143°W
142°
141°

4.9 STATION PROFILE PLOTS

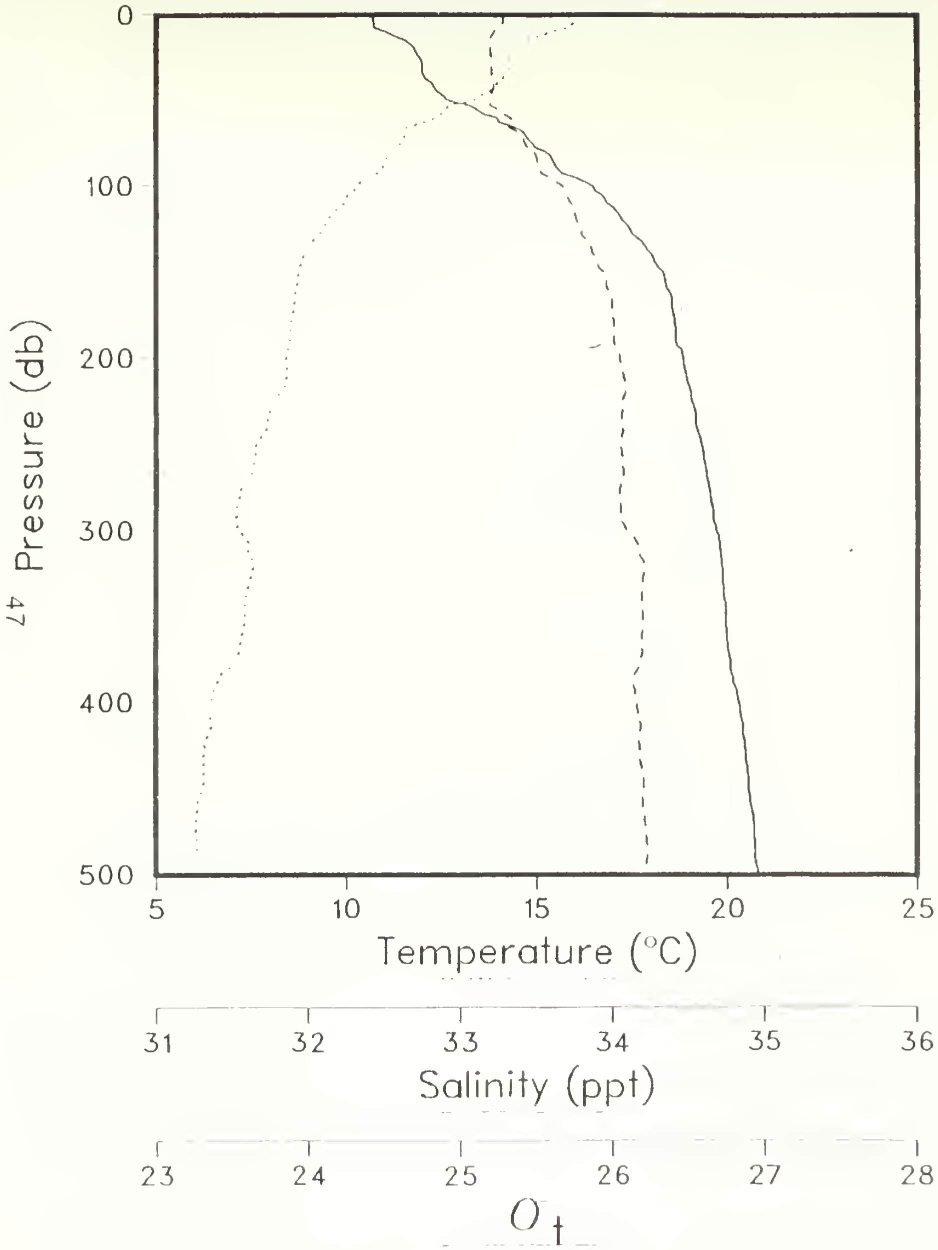
(Temperature, Salinity, Density, c(665), Fluorescence, and dissolved Oxygen)

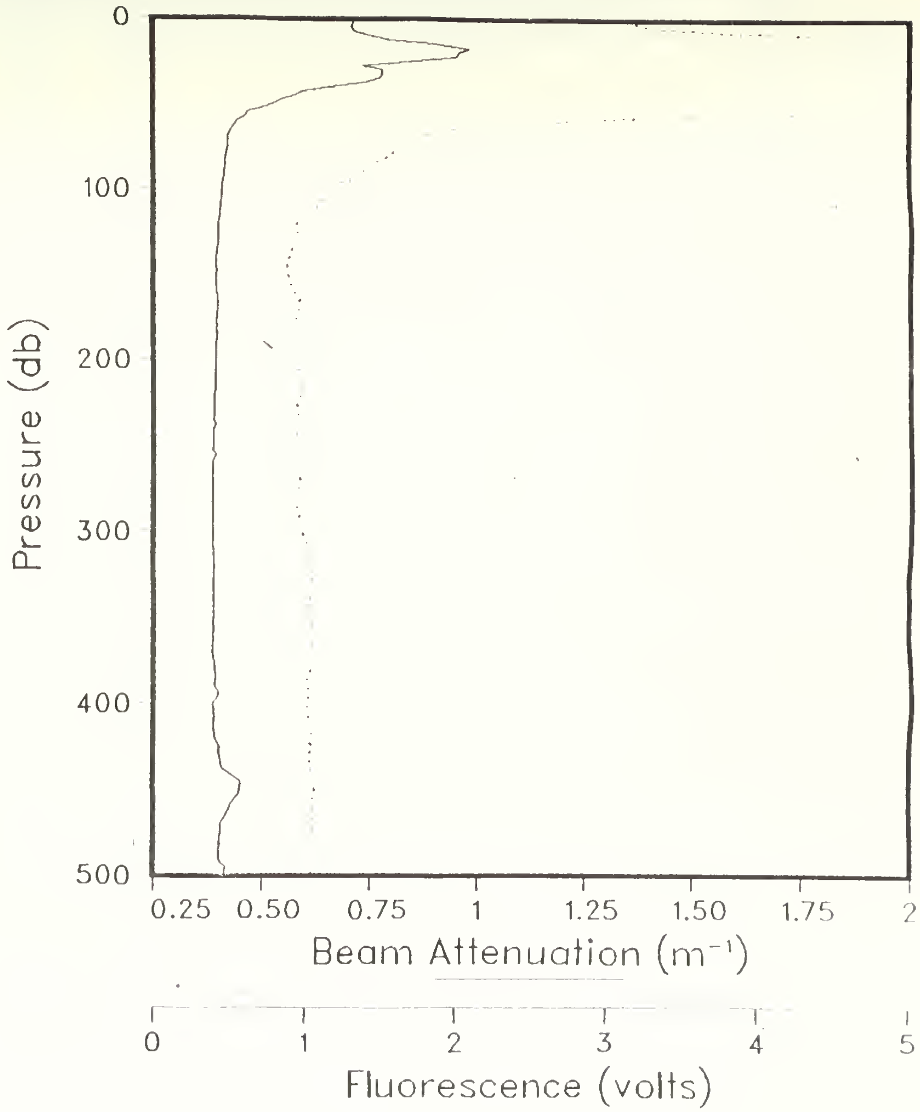


Latitude: 35.667°
Longitude: 122.000°

Date: 10/11/82
Time: 2109:53 GMT

R/V ACANIA CRUISE ODEX3 STATION 2

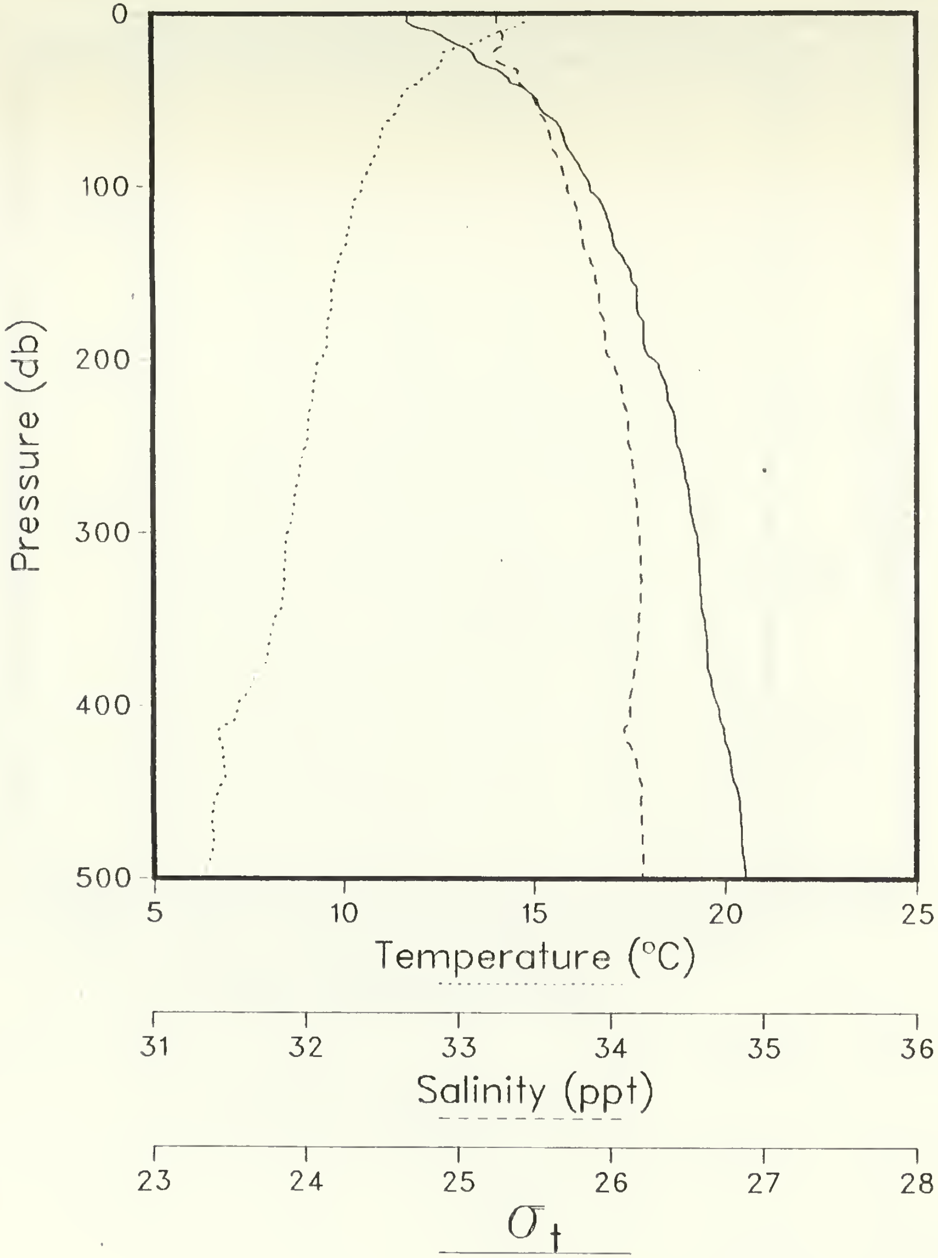


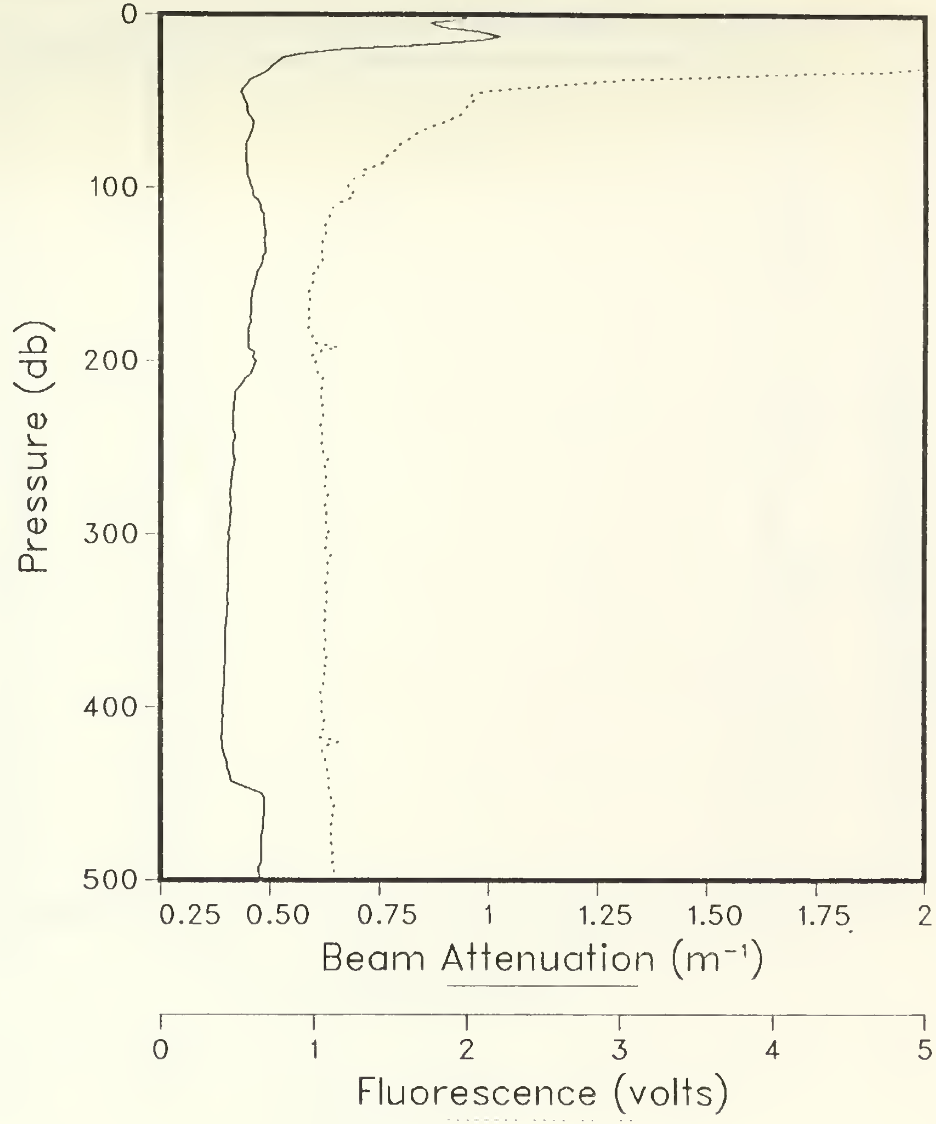


Latitude: 35.668°
Longitude: 121.817°

Date: 10/11/82
Time: 2323:03 GMT

R/V ACANIA CRUISE ODEX3 STATION 3

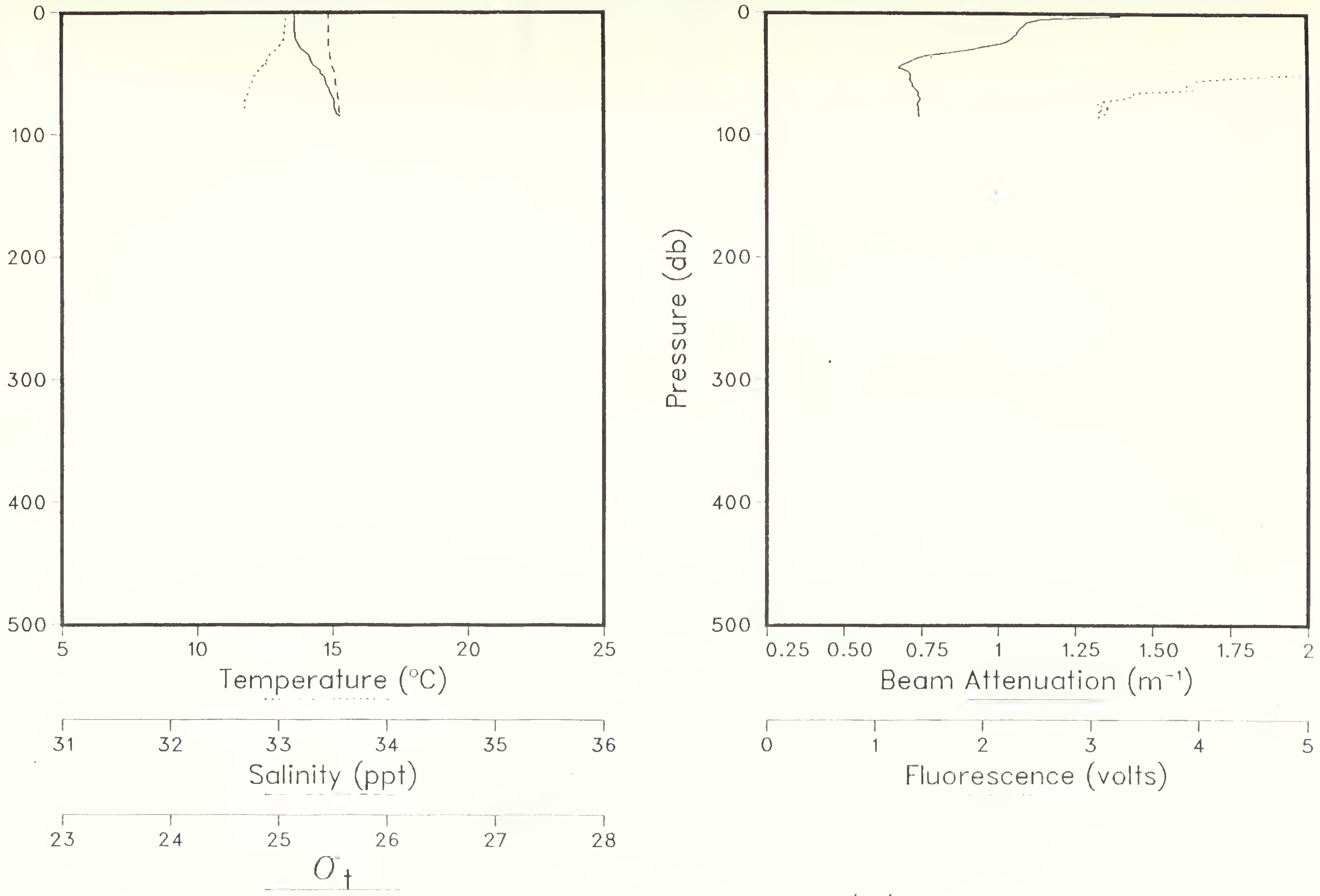




Latitude: 35.662°
Longitude: 121.551°

Date: 10/12/82
Time: 332:47 GMT

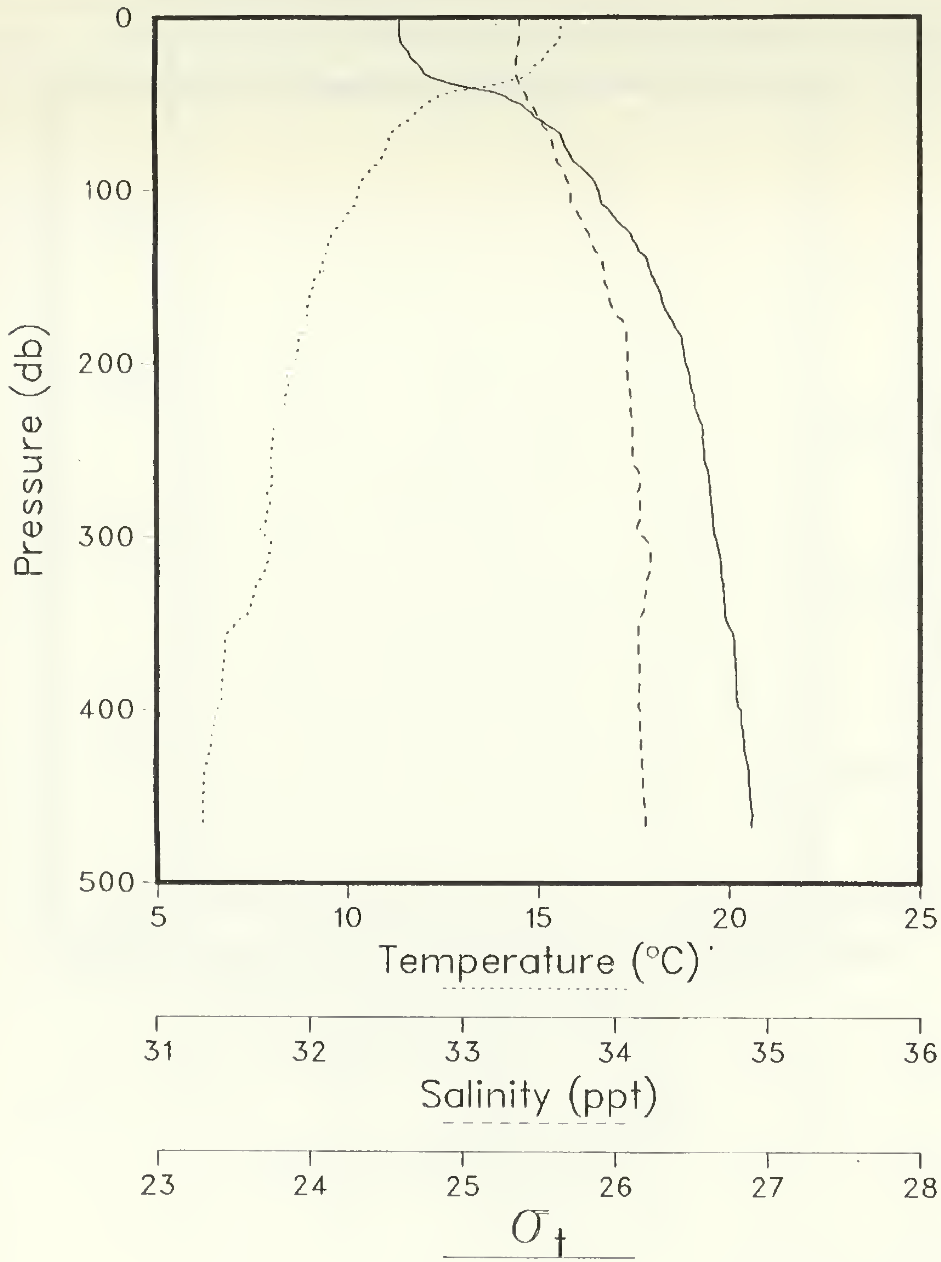
R/V ACANIA CRUISE ODEX3 STATION 4

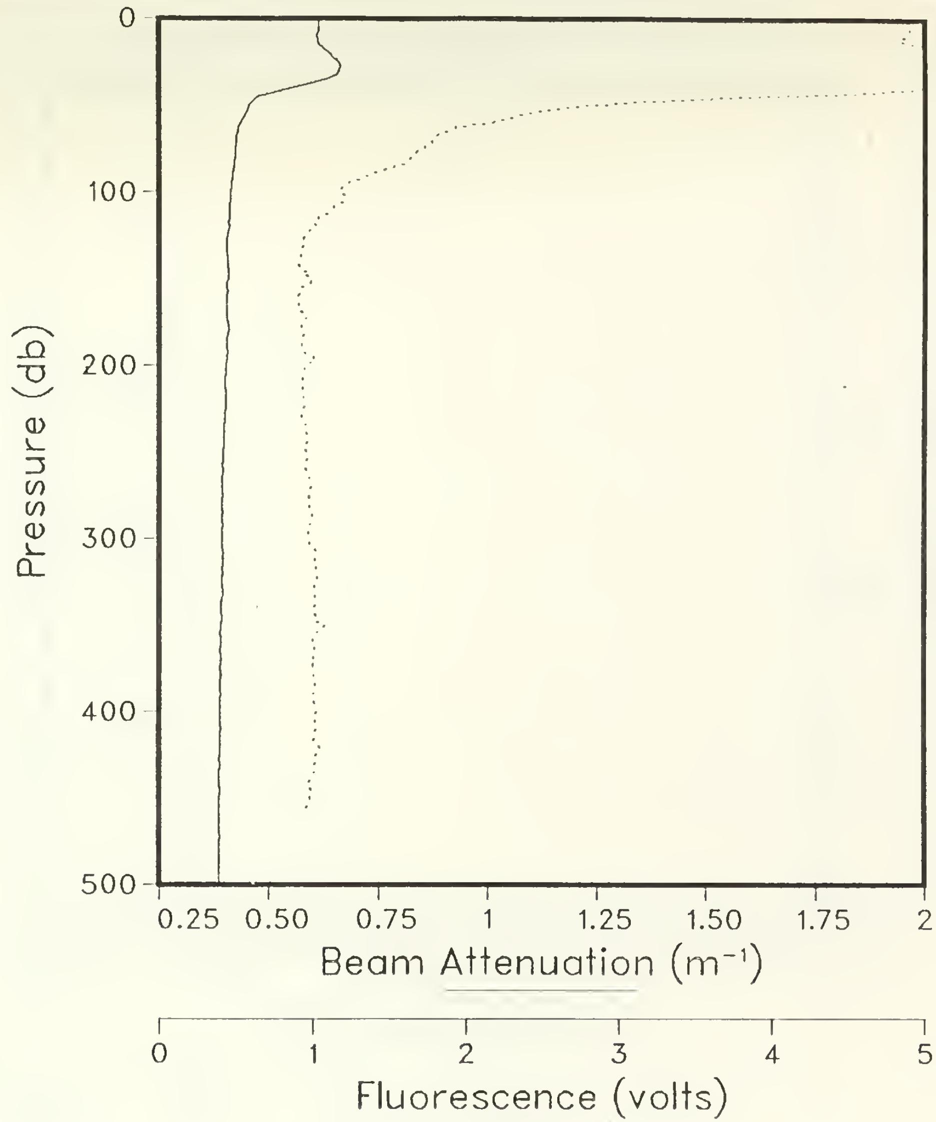


Latitude: 35.667°
Longitude: 121.367°

Date: 10/12/82
Time: 545:07 GMT

R/V ACANIA CRUISE ODEX3 STATION 5

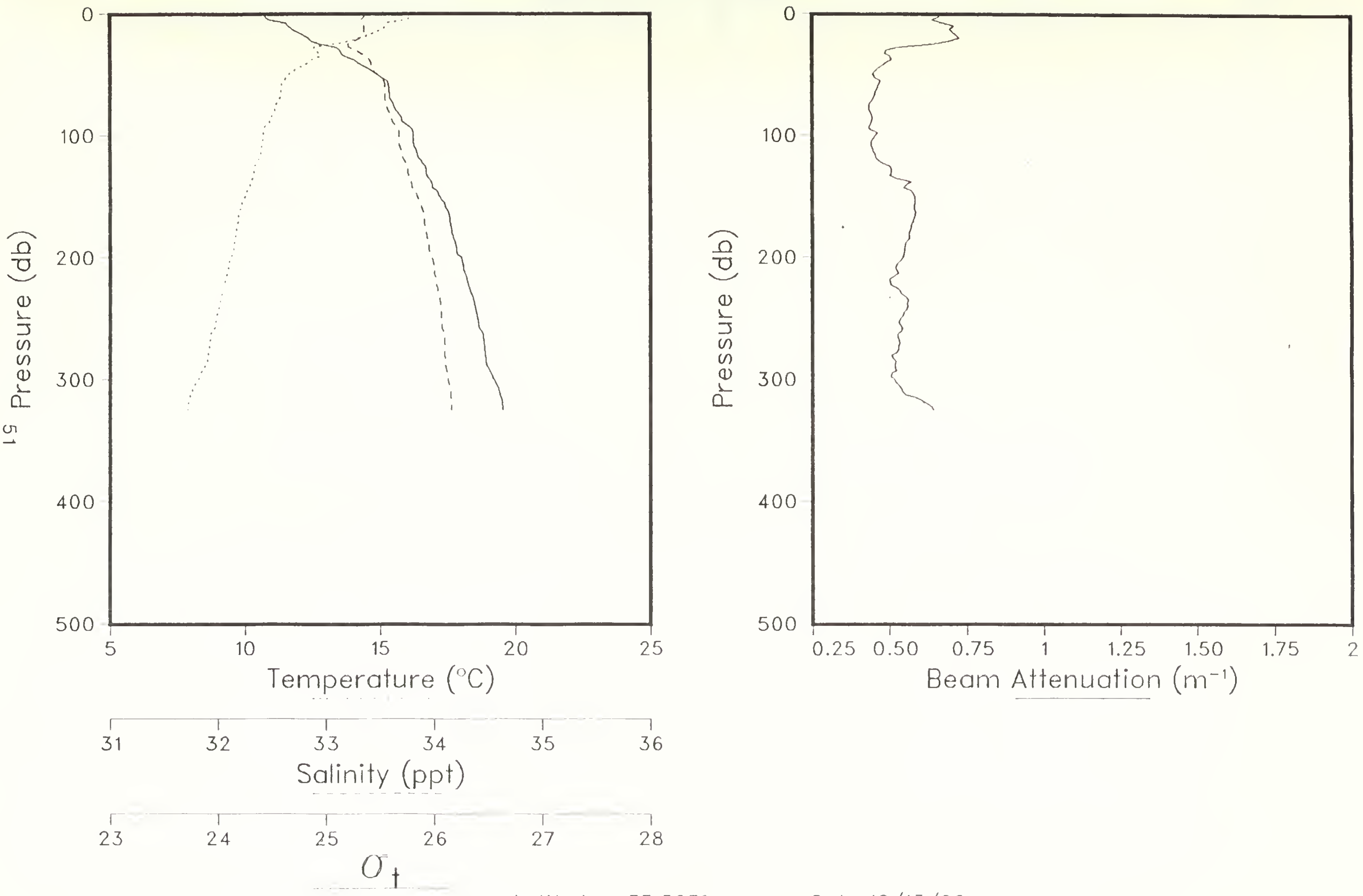




Latitude: 35.315°
Longitude: 121.367°

Date: 10/12/82
Time: 1527:14 GMT

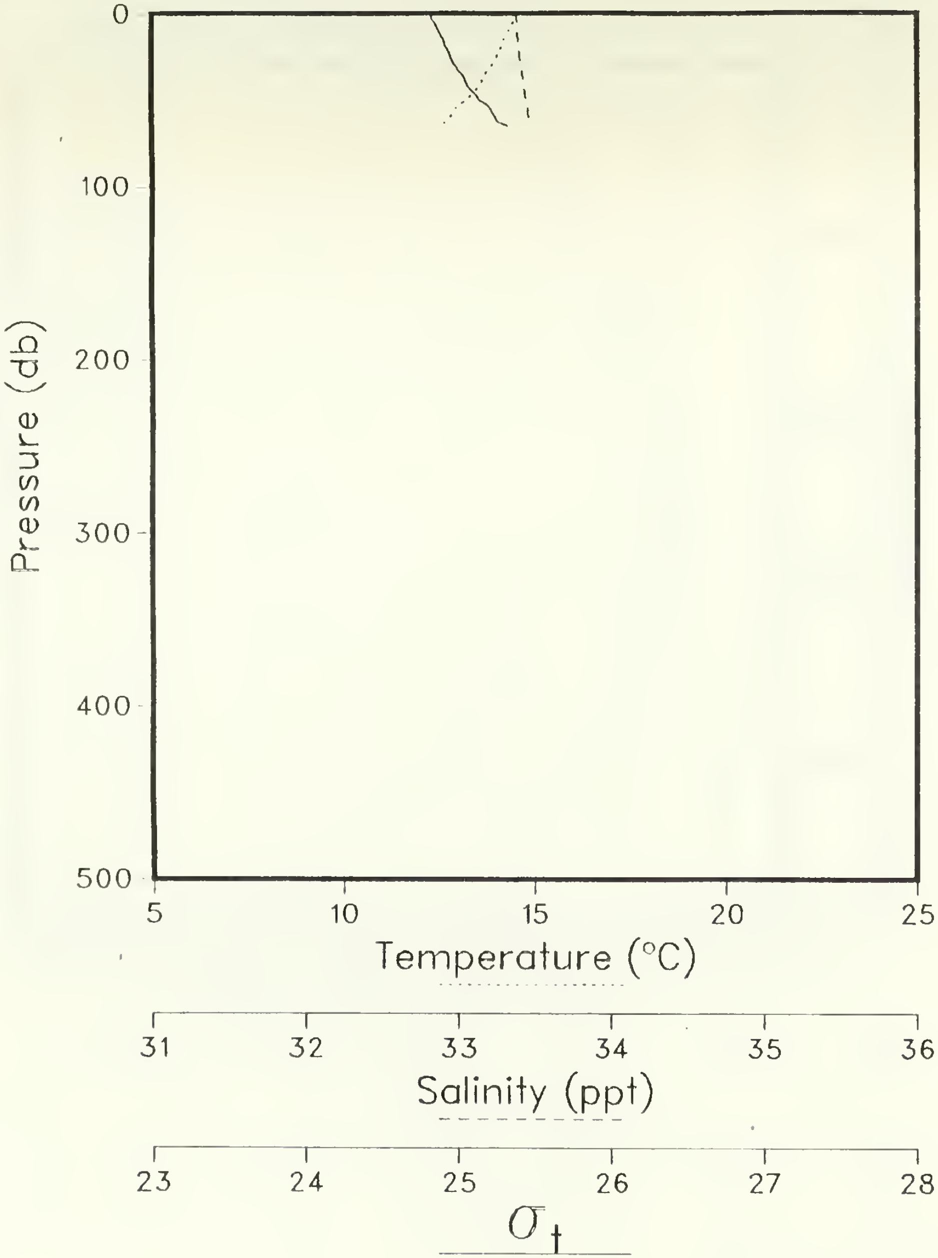
R/V ACANIA CRUISE ODEX3 STATION 6

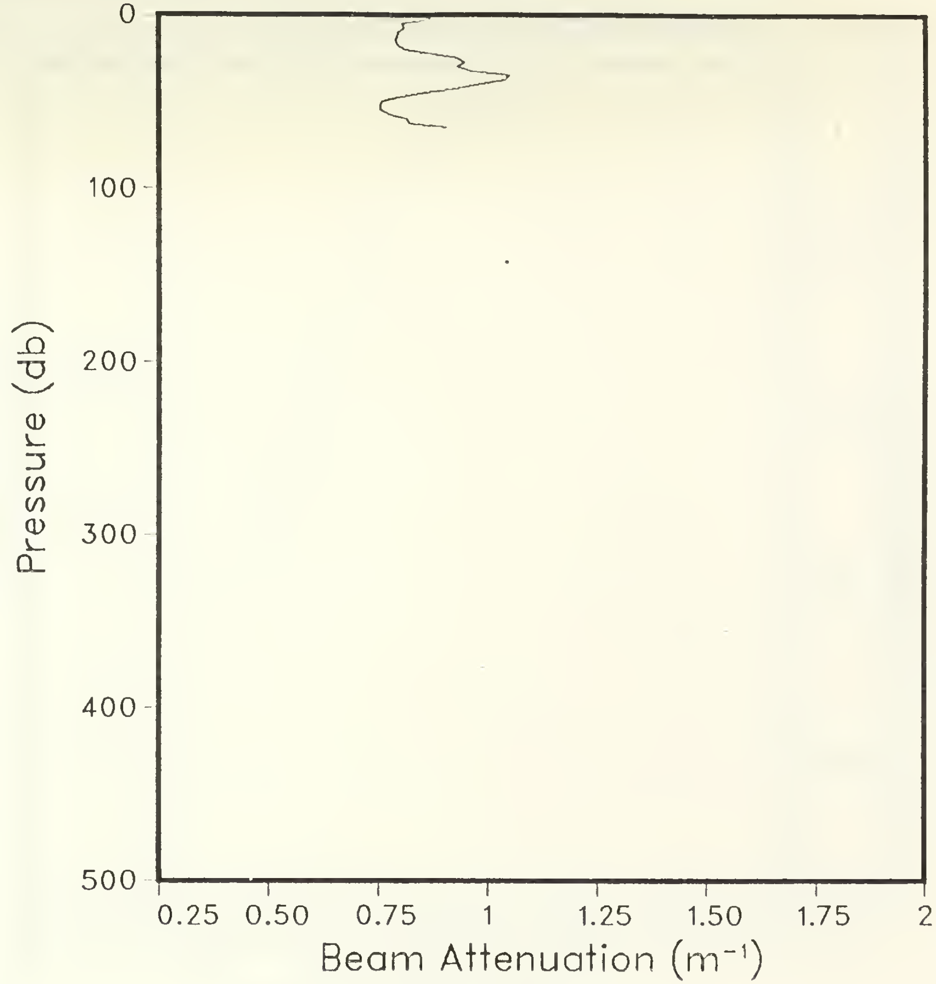


Latitude: 35.323°
Longitude: 121.115°

Date: 10/13/82
Time: 18:09 GMT

R/V ACANIA CRUISE ODEX3 STATION 9

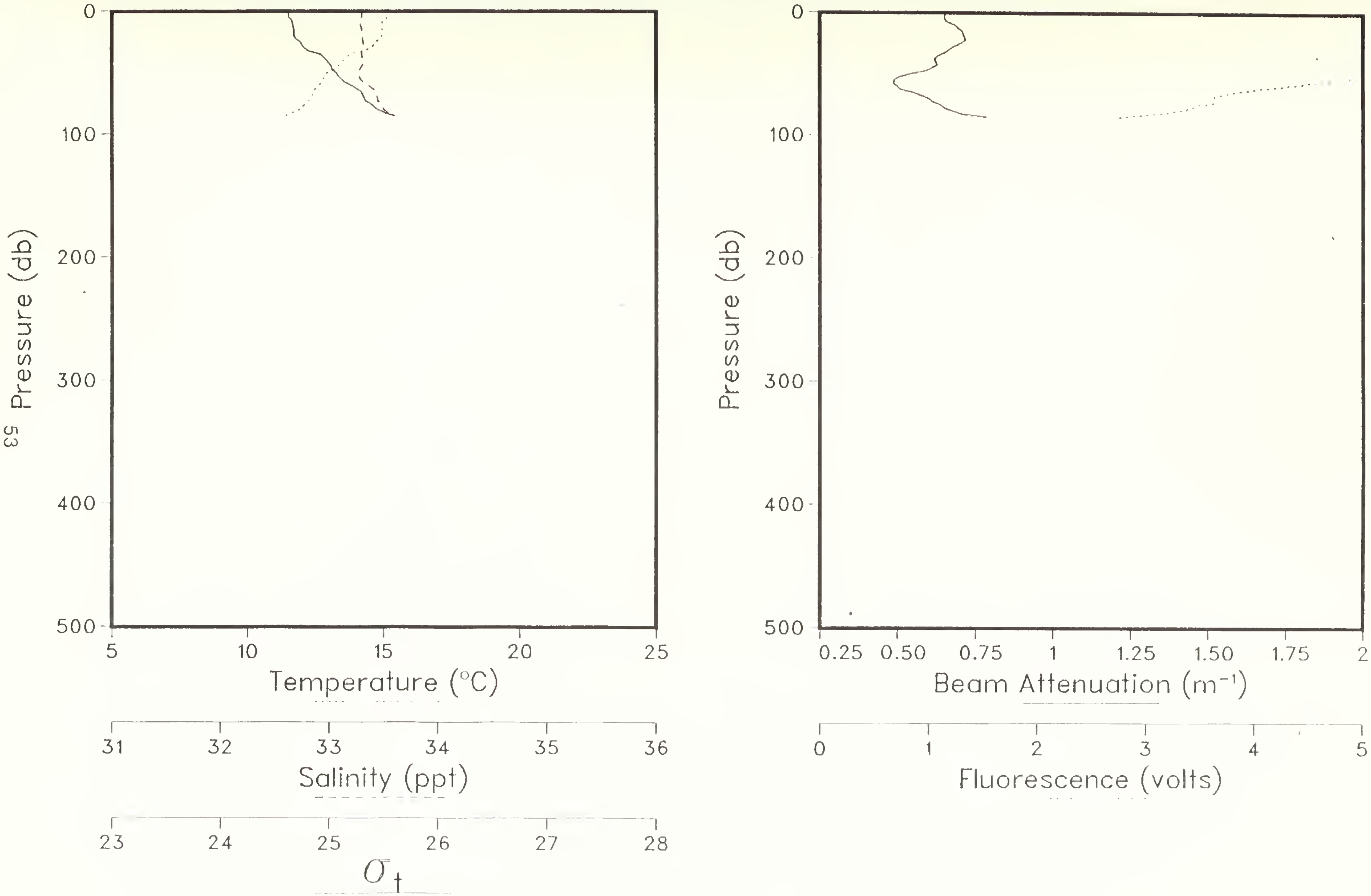




Latitude: 35.322°
Longitude: 120.933°

Date: 10/13/82
Time: 227:09 GMT

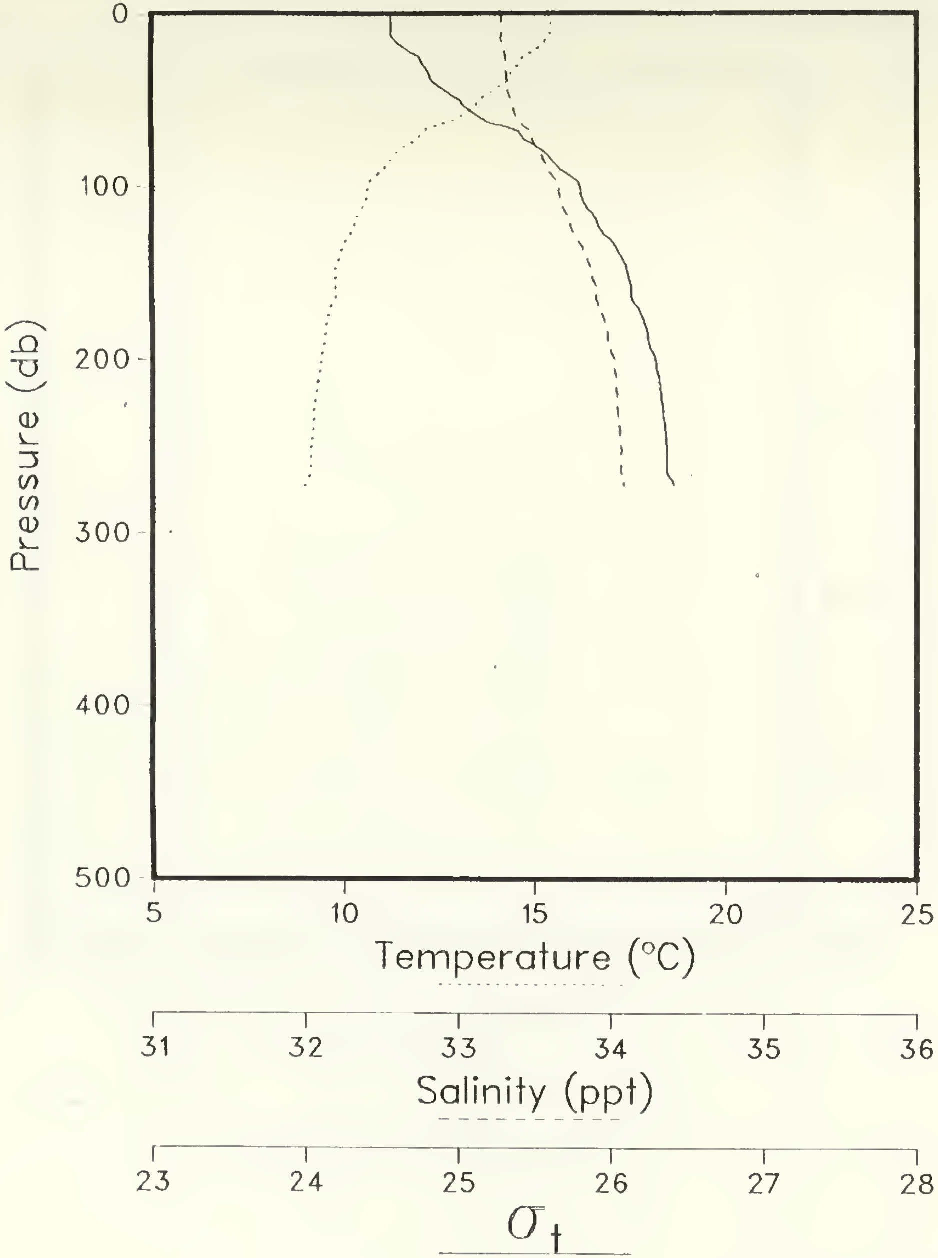
R/V ACANIA CRUISE ODEX3 STATION 10

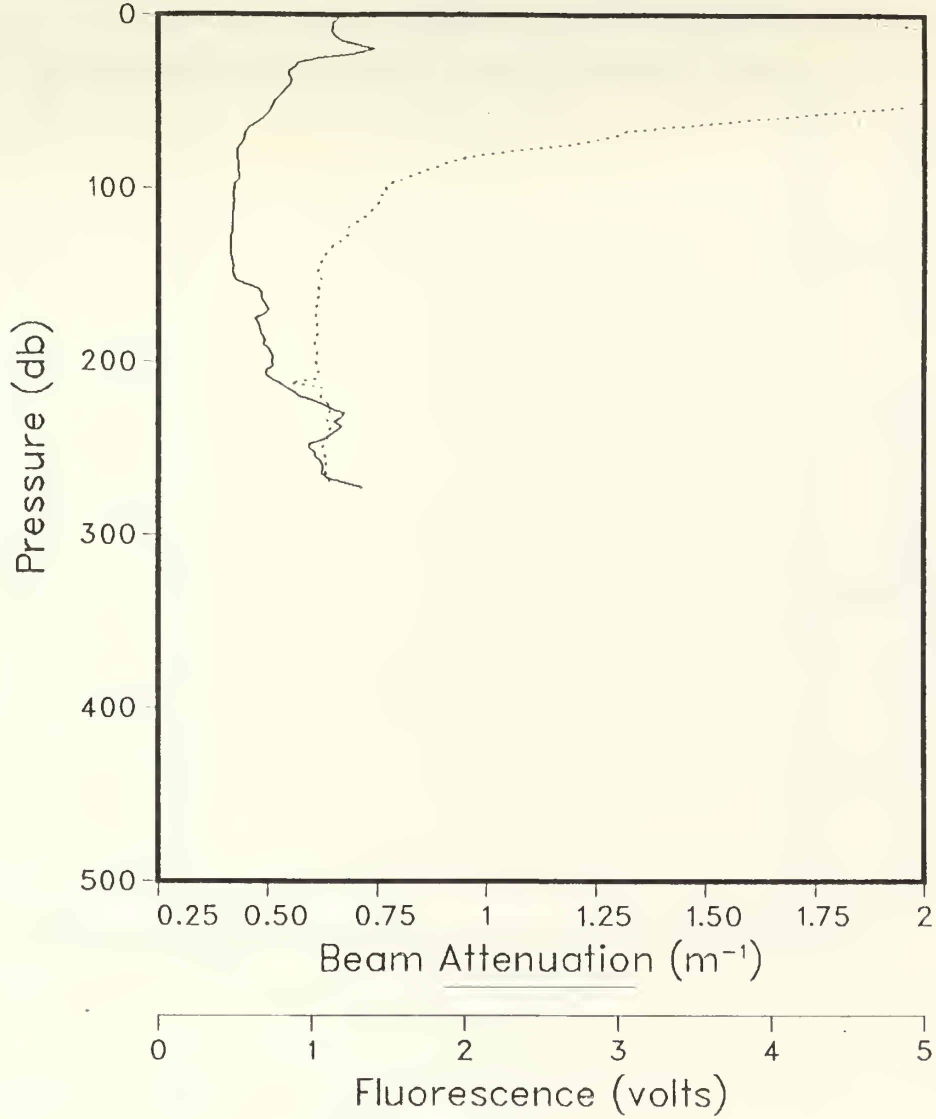


Latitude: 34.997° Longitude: 120.783°

Date: 10/14/82 Time: 1413:57 GMT

R/V ACANIA CRUISE ODEX3 STATION 11

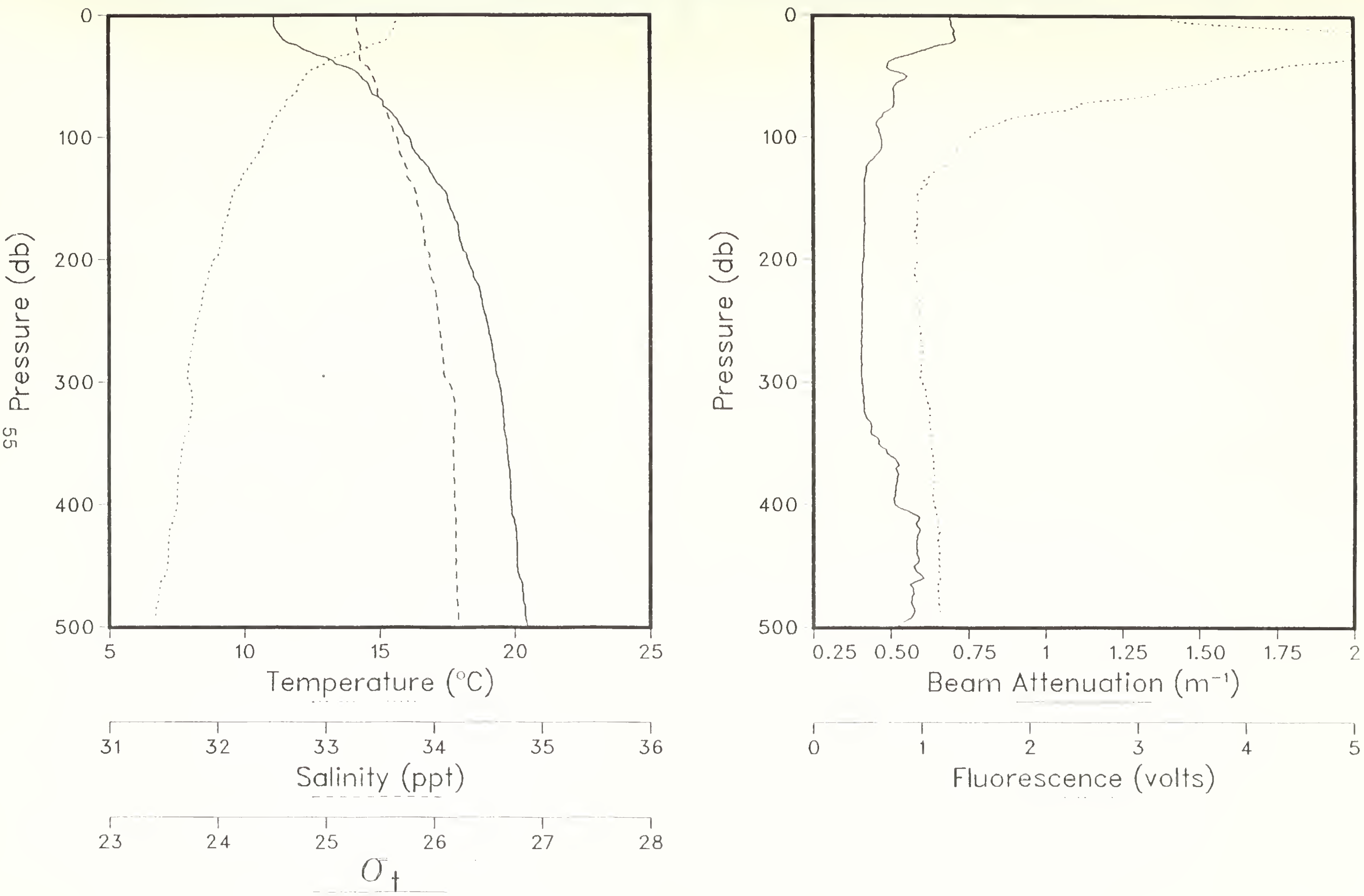




Latitude: 35.000°
Longitude: 120.937°

Date: 10/14/82
Time: 1615:37 GMT

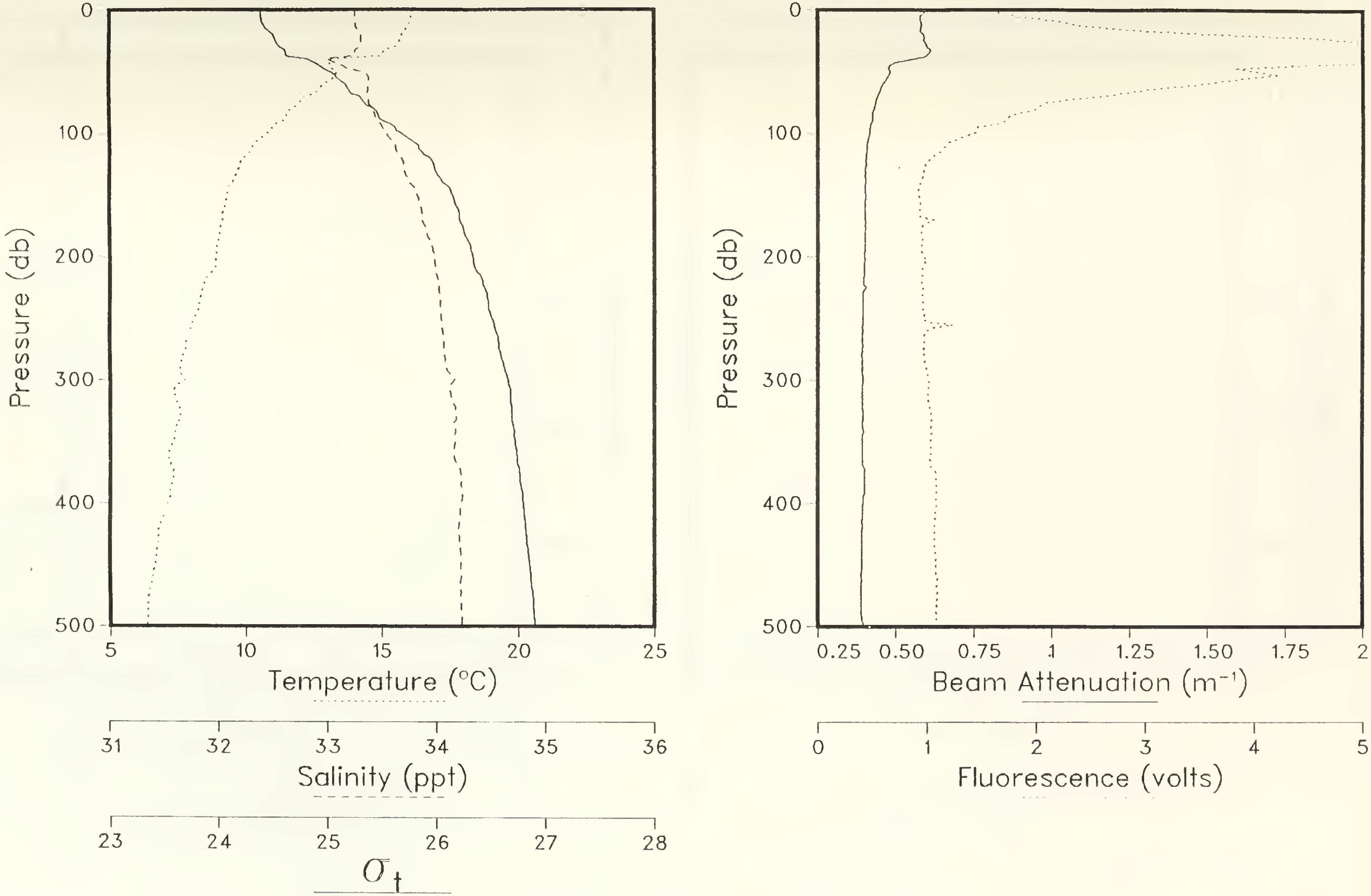
R/V ACANIA CRUISE ODEX3 STATION 12



Latitude: 34.994°
Longitude: 121.084°

Date: 10/14/82
Time: 1847:15 GMT

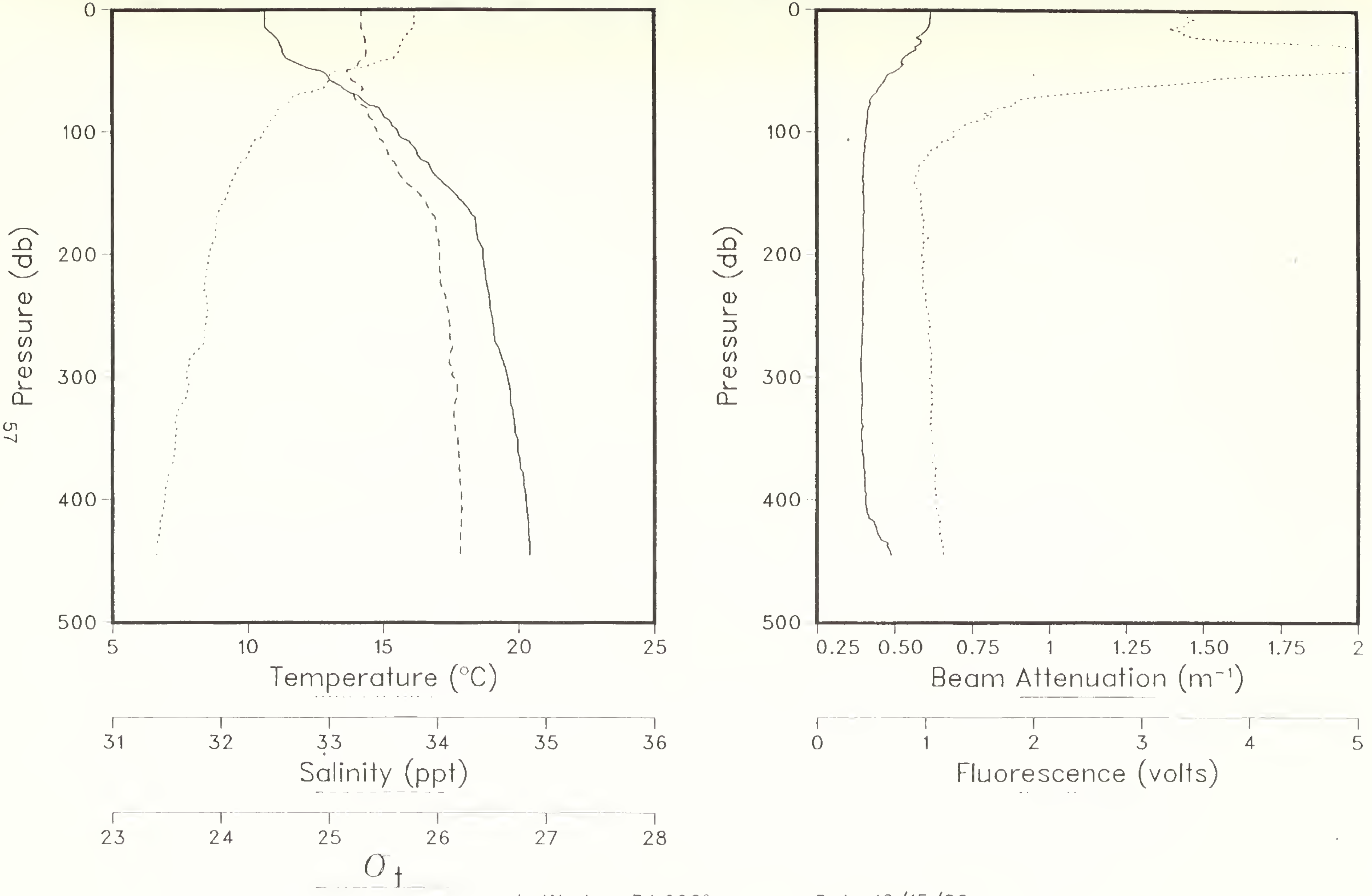
R/V ACANIA CRUISE ODEX3 STATION 13



Latitude: 34.998°
Longitude: 121.218°

Date: 10/14/82
Time: 2120:32 GMT

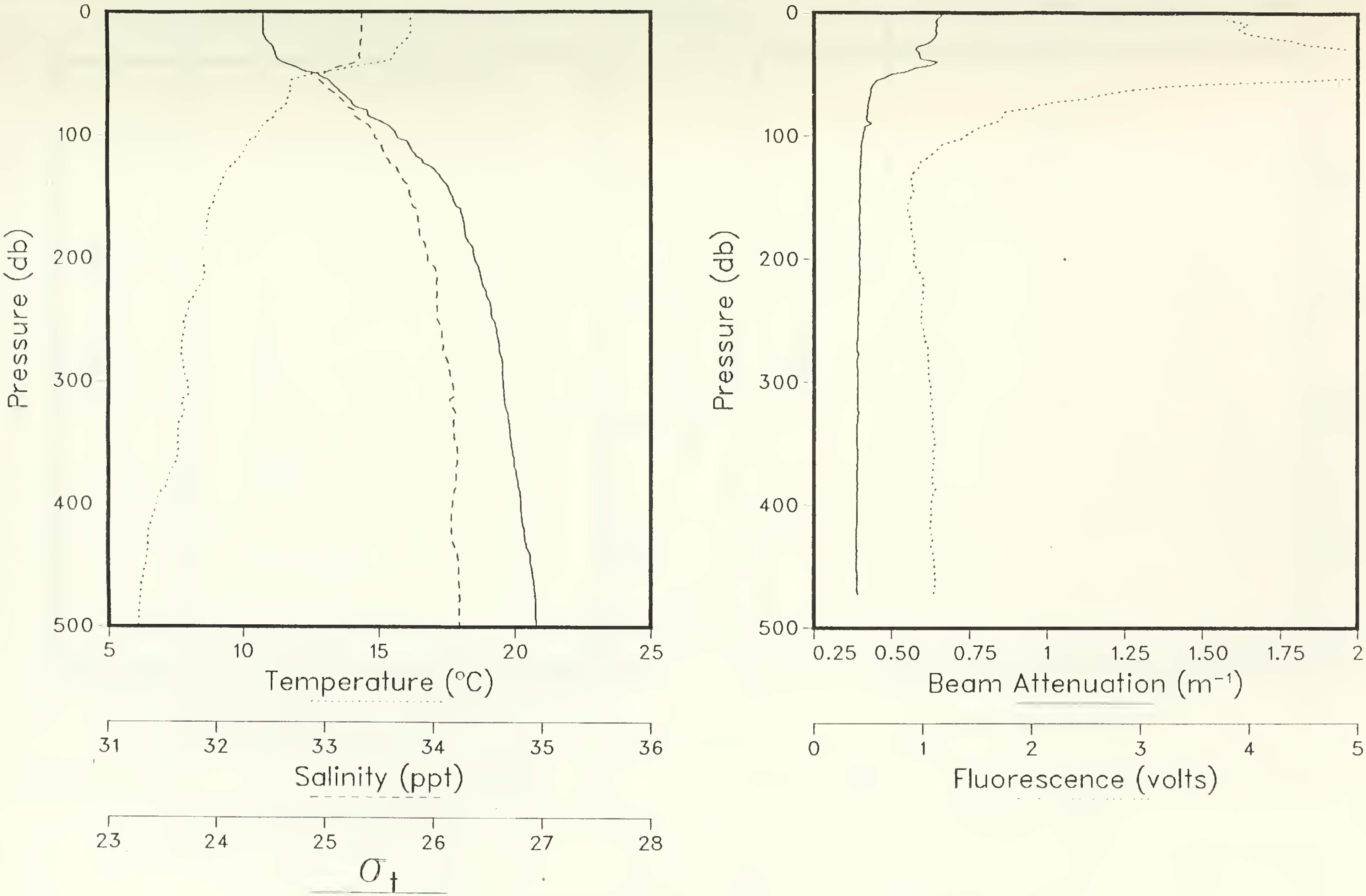
R/V ACANIA CRUISE ODEX3 STATION 14



Latitude: 34.996°
Longitude: 121.402°

Date: 10/15/82
Time: 113:50 GMT

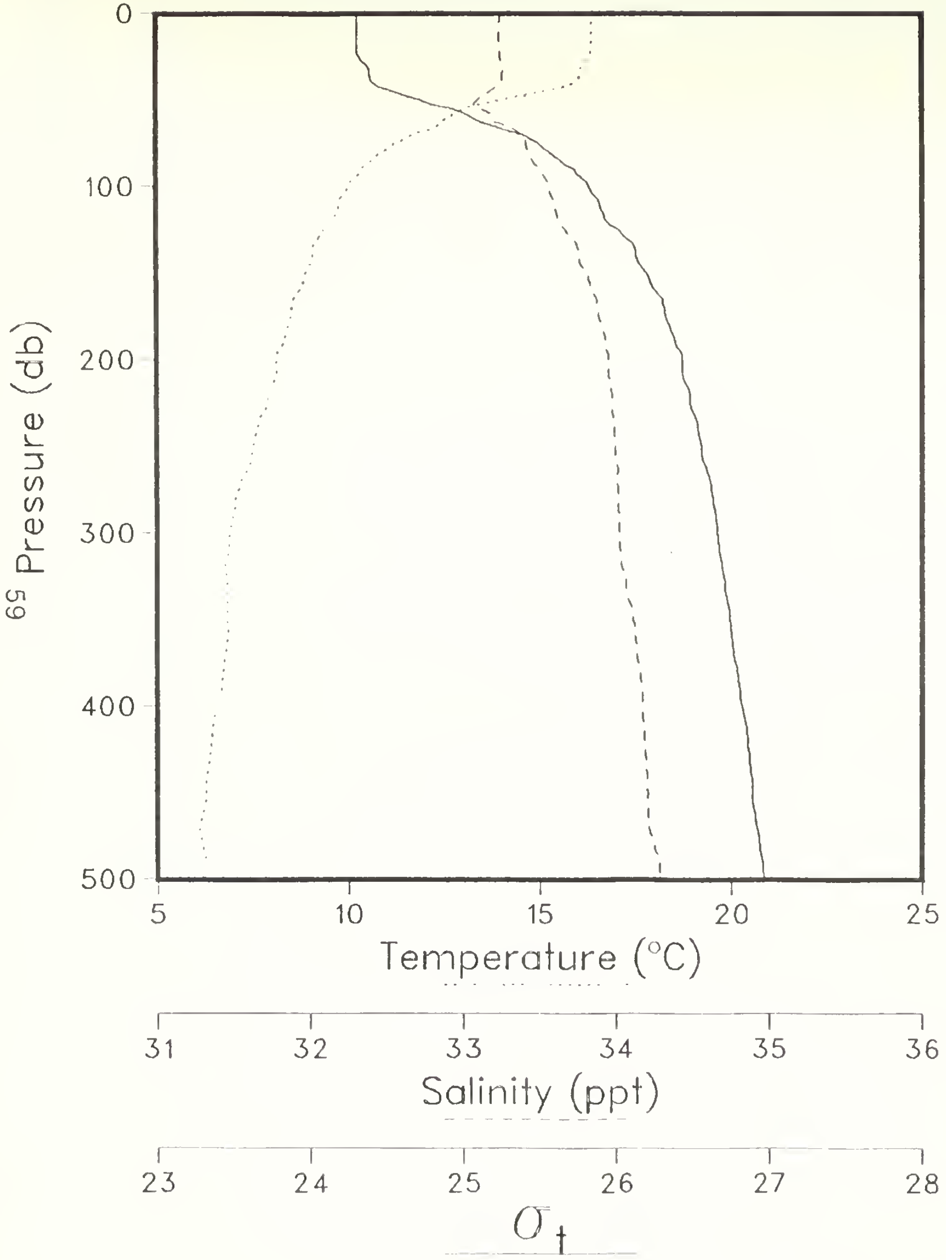
R/V ACANIA CRUISE ODEX3 STATION 15

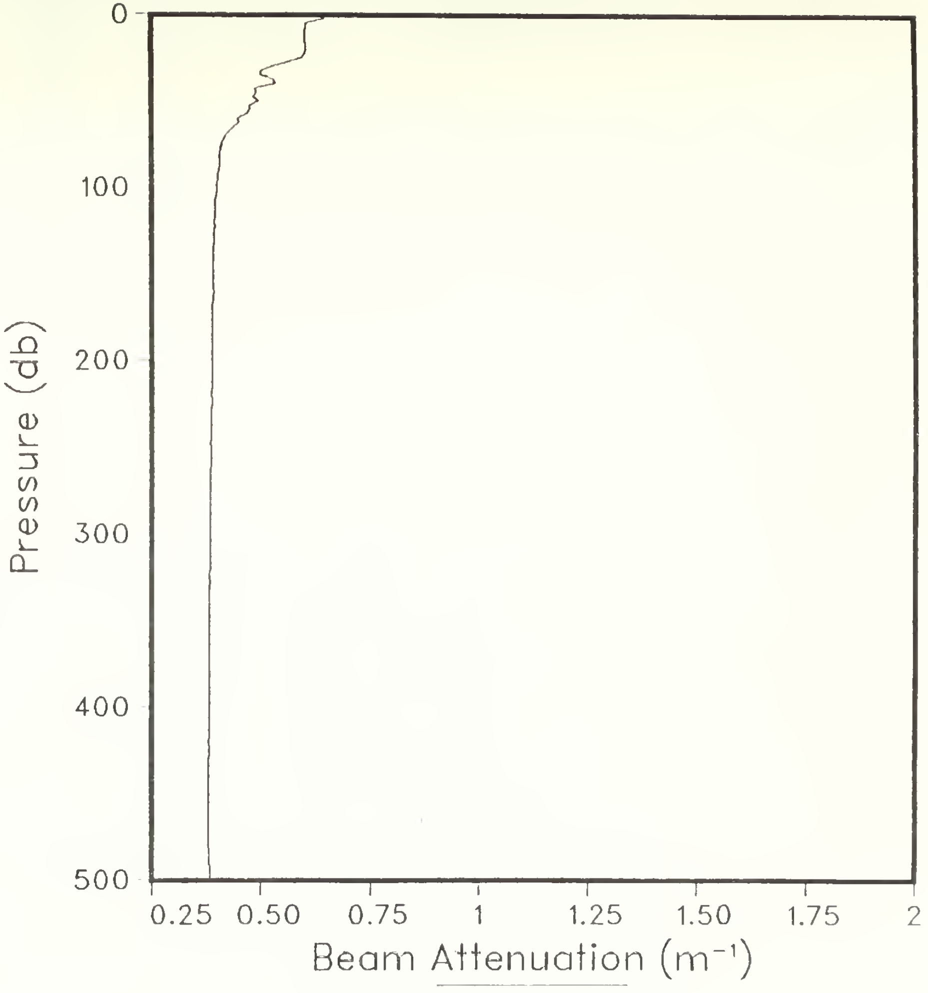


Latitude: 34.998°
Longitude: 121.518°

Date: 10/15/82
Time: 315:24 GMT

R/V ACANIA CRUISE ODEX3 STATION 16

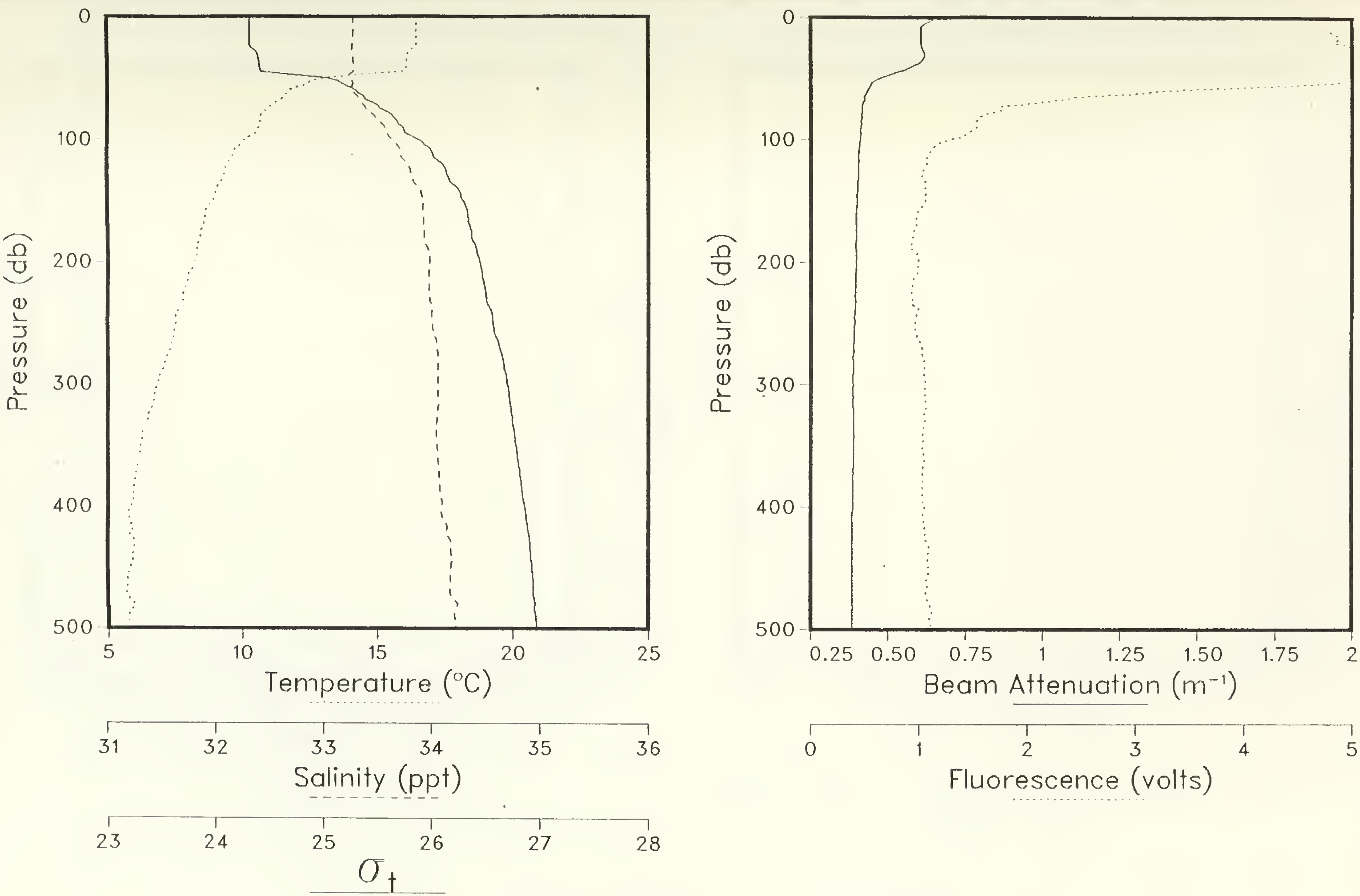




Latitude: 34.999°
Longitude: 121.655°

Date: 10/15/82
Time: 519:49 GMT

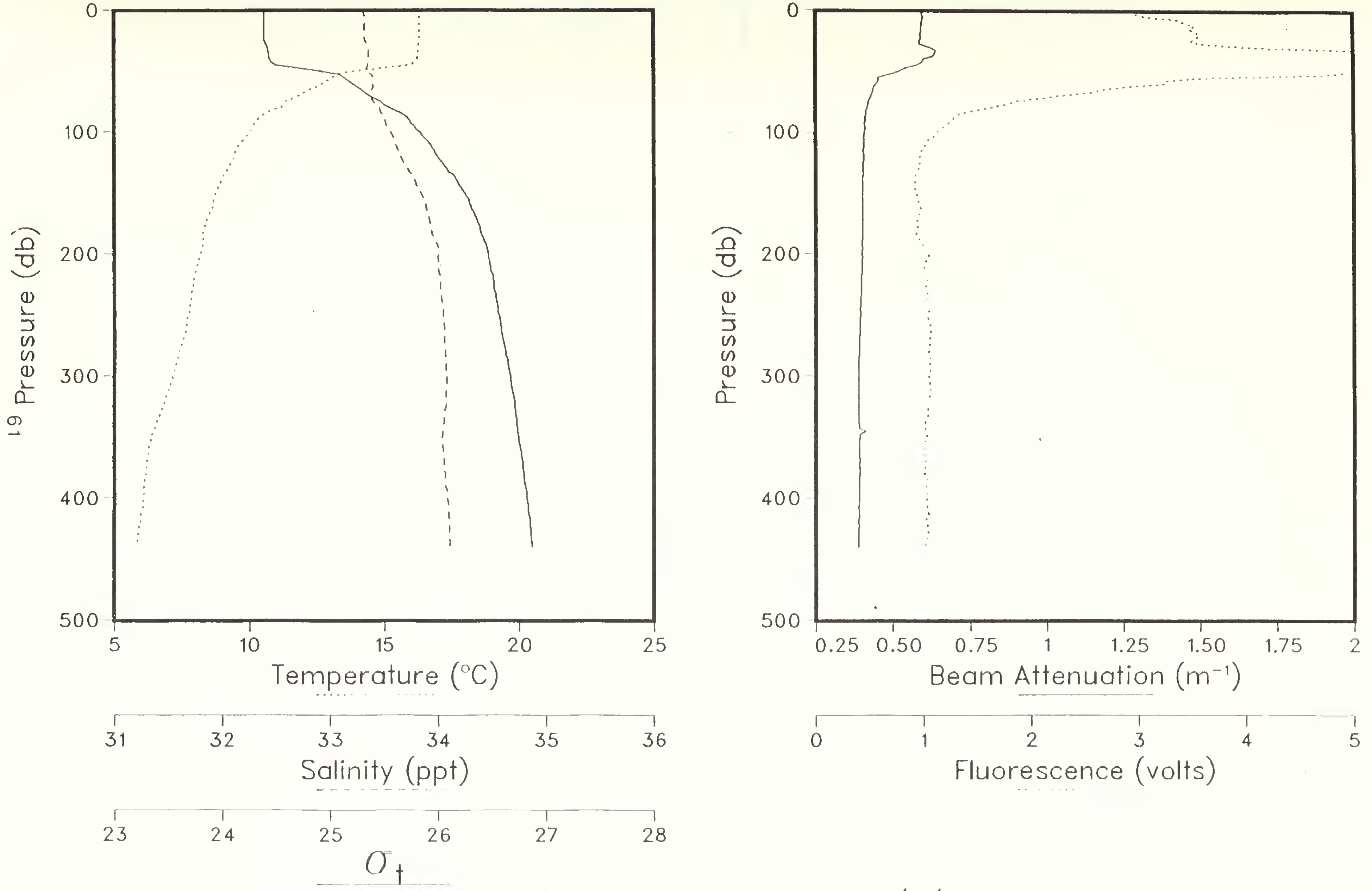
R/V ACANIA CRUISE ODEX3 STATION 17



Latitude: 34.999°
Longitude: 121.802°

Date: 10/15/82
Time: 729:05 GMT

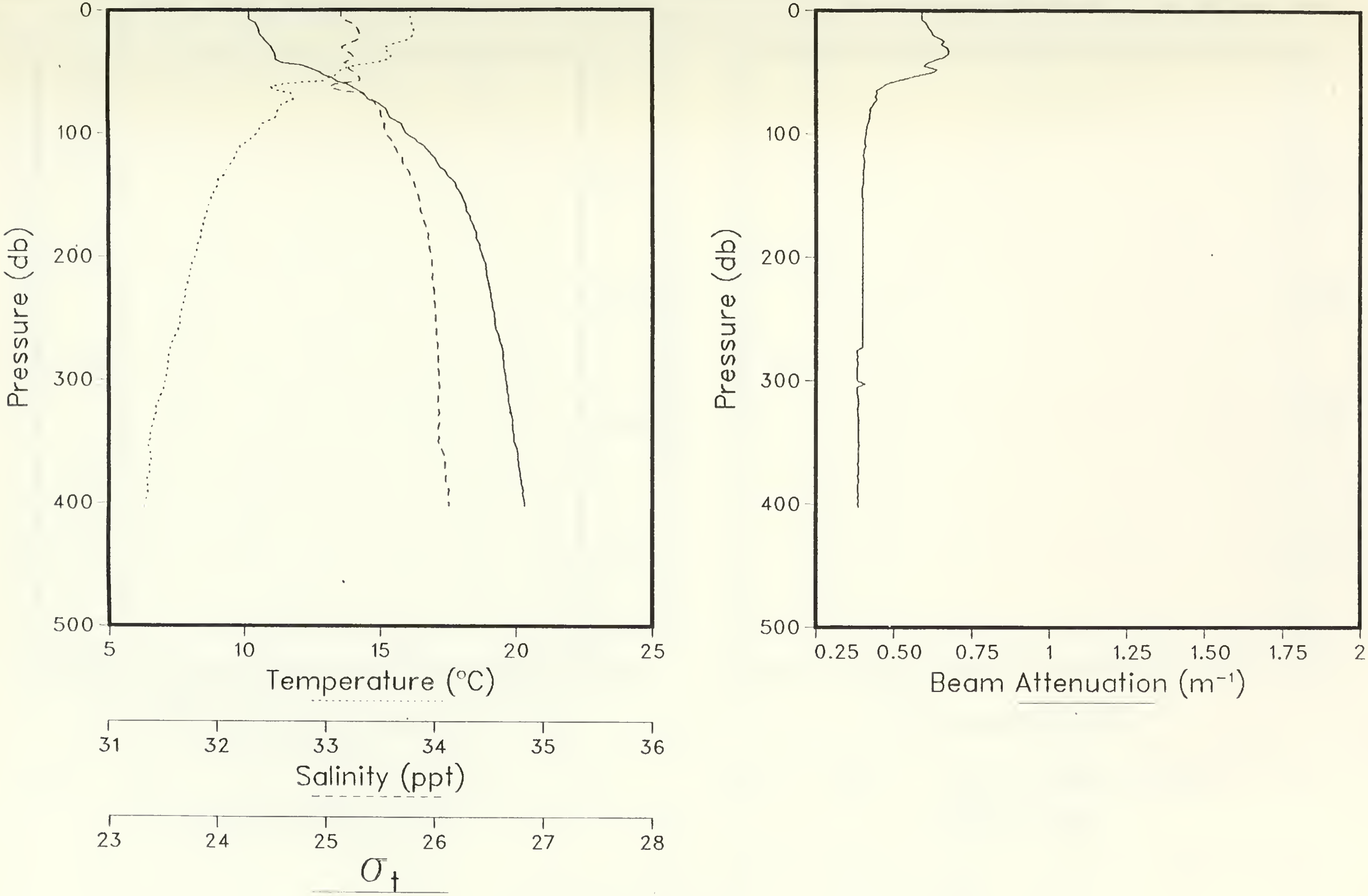
R/V ACANIA CRUISE ODEX3 STATION 18



Latitude: 34.991°
Longitude: 122.705°

Date: 10/15/82
Time: 1528:26 GMT

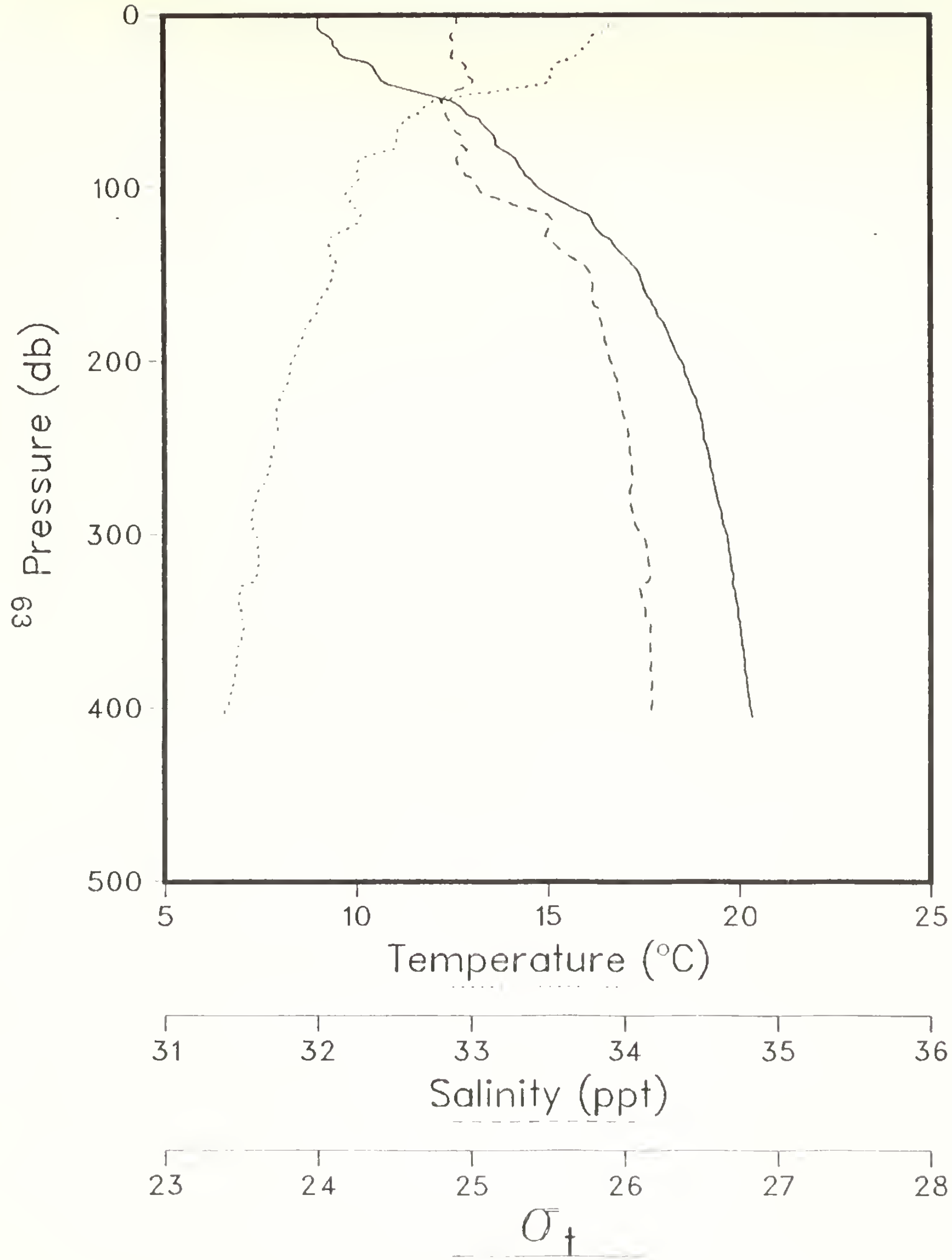
R/V ACANIA CRUISE ODEX3 STATION 19

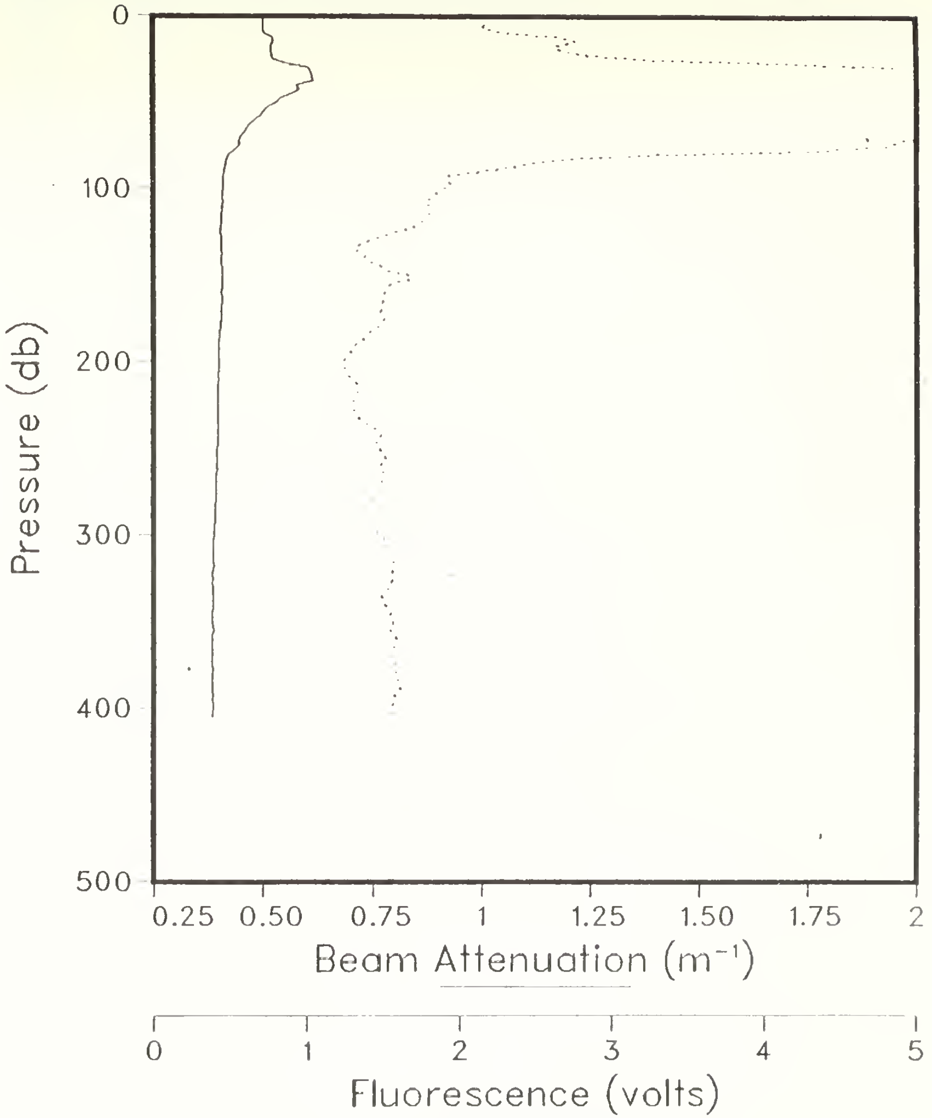


Latitude: 34.962°
Longitude: 123.021°

Date: 10/15/82
Time: 2144:57 GMT

R/V ACANIA CRUISE ODEX3 STATION 20A

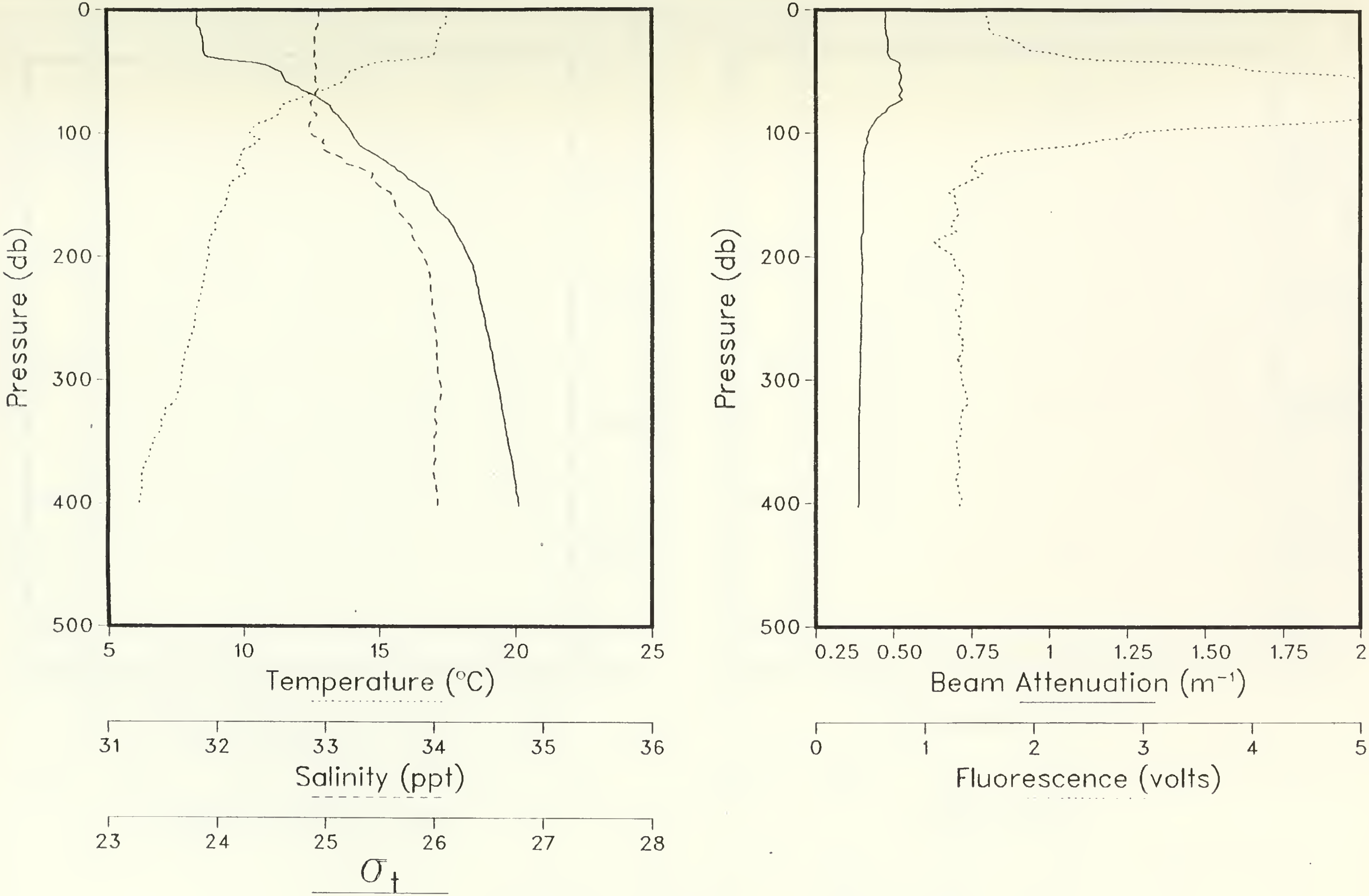




Latitude: 35.000°
Longitude: 123.232°

Date: 10/16/82
Time: 2:00 GMT

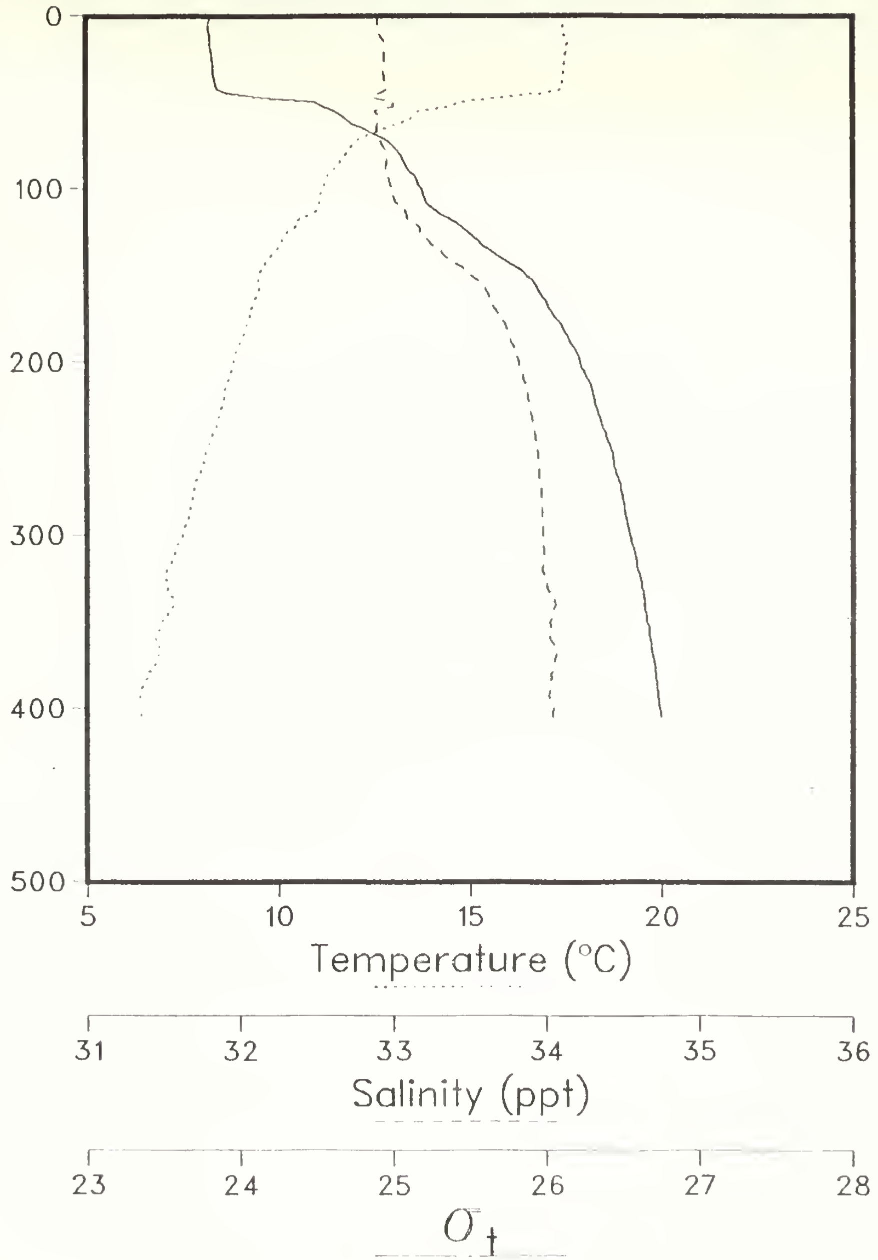
R/V ACANIA CRUISE ODEX3 STATION 21

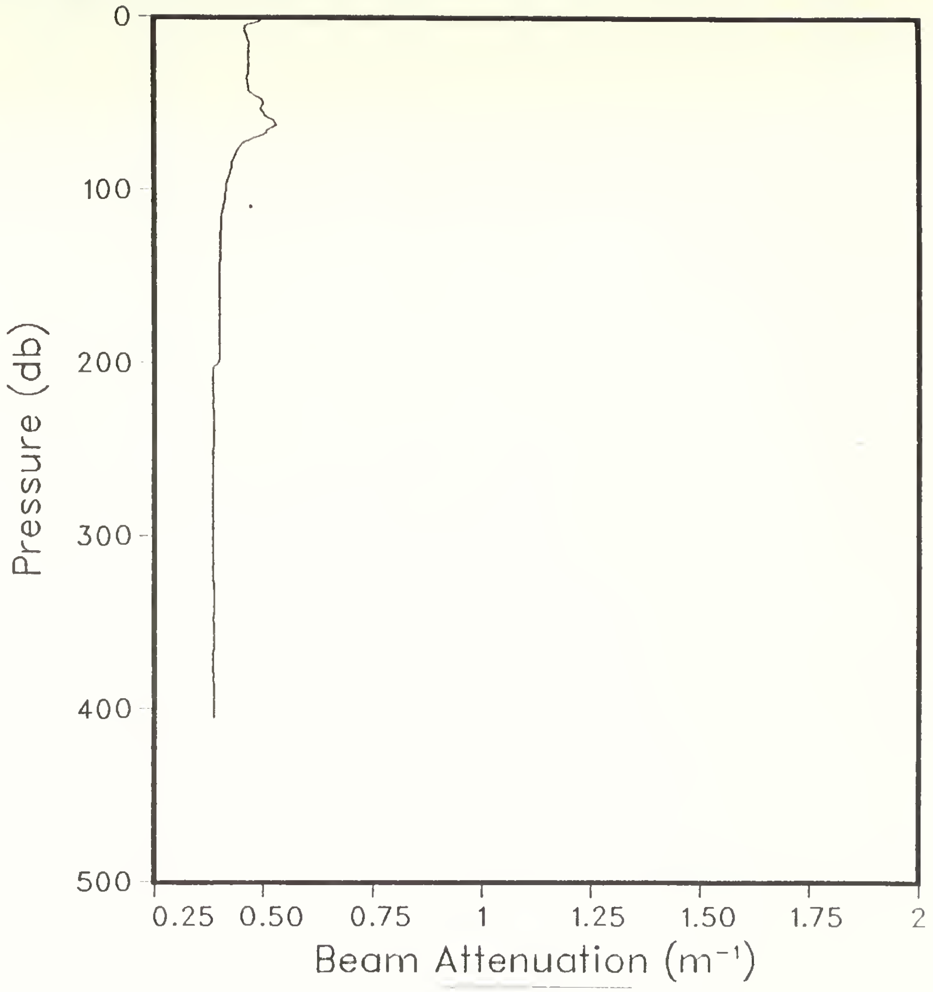


Latitude: 34.947°
Longitude: 123.972°

Date: 10/16/82
Time: 713:11 GMT

R/V ACANIA CRUISE ODEX3 STATION 22

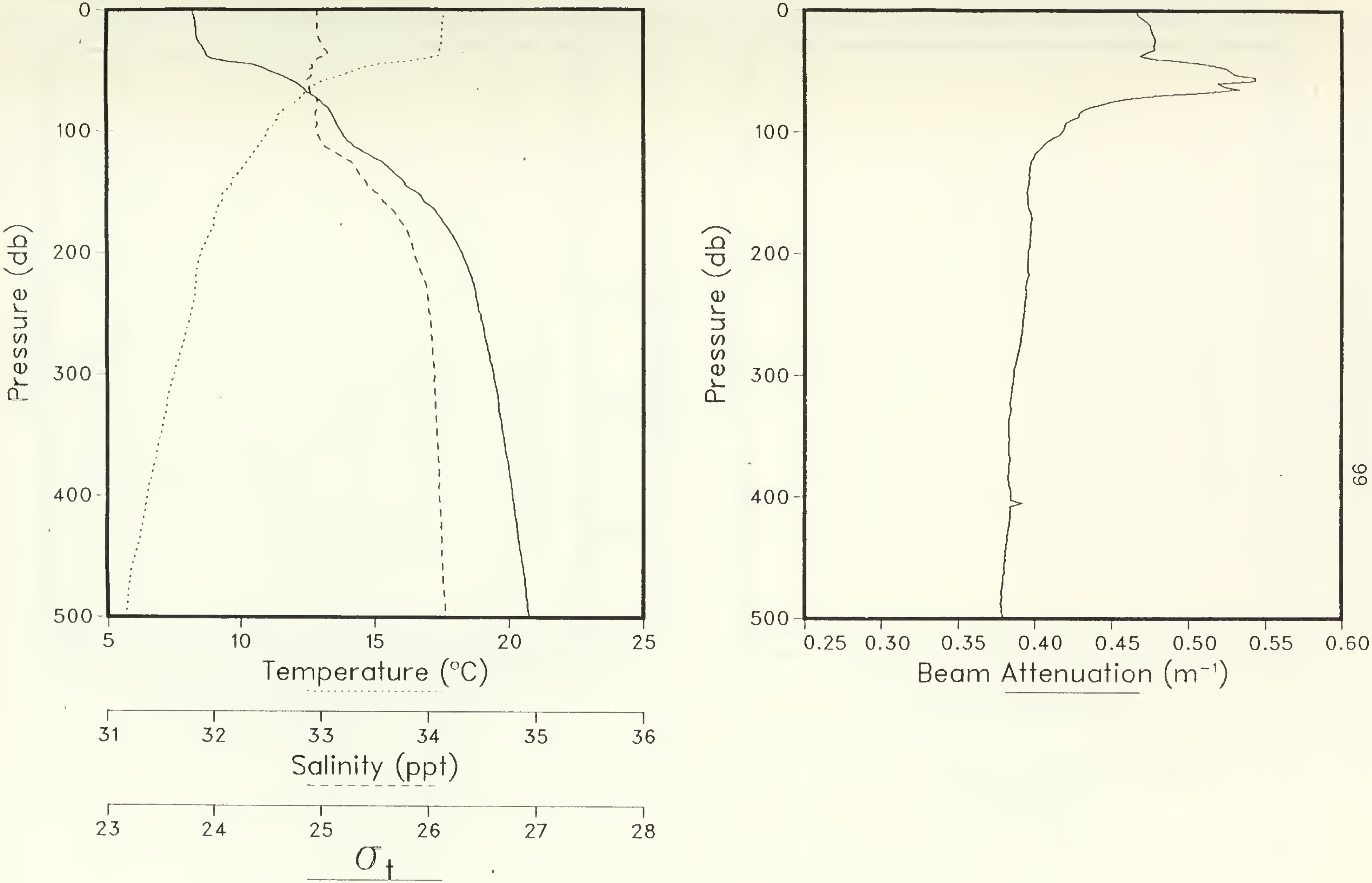




Latitude: 34.989°
Longitude: 124.860°

Date: 10/16/82
Time: 1438:40 GMT

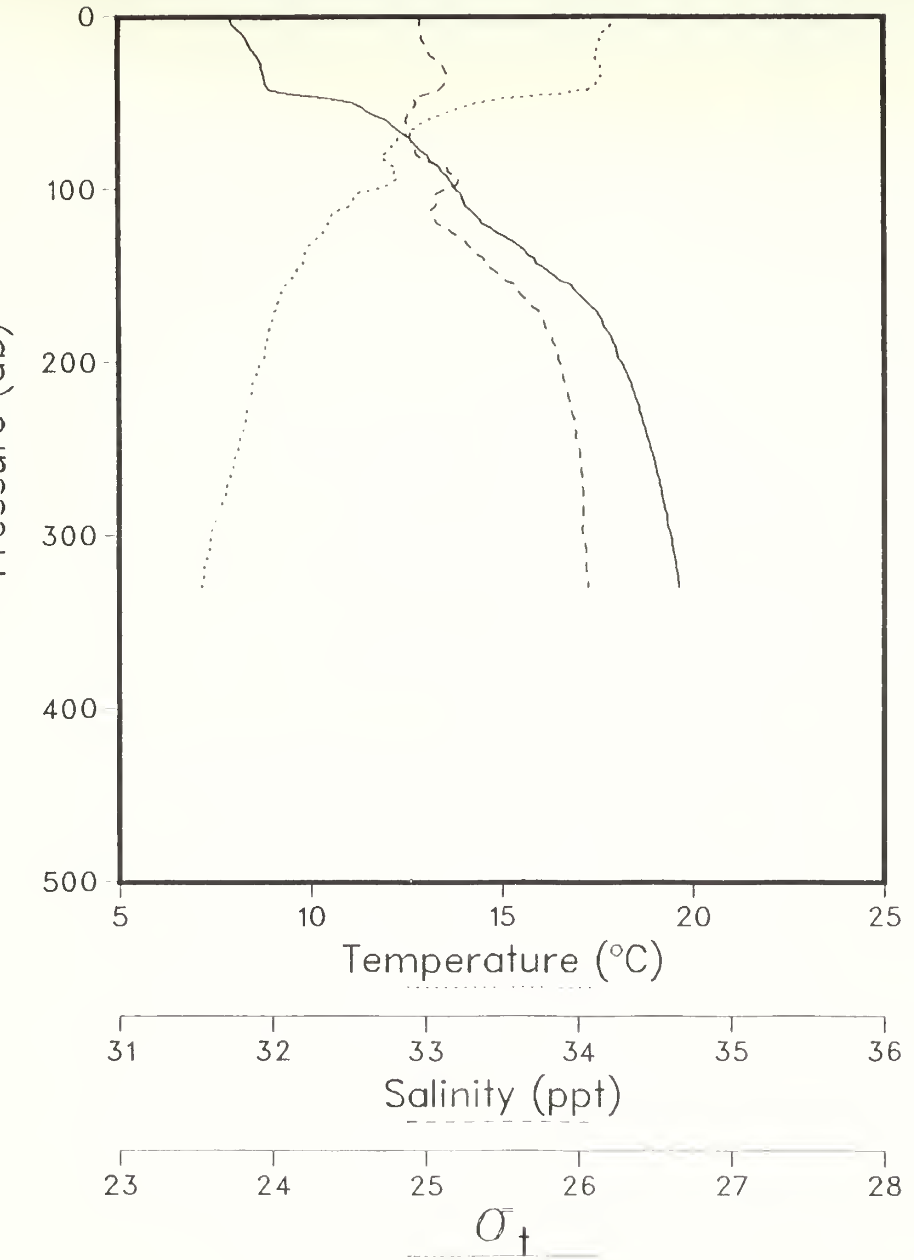
R/V ACANIA CRUISE ODEX3 STATION 23

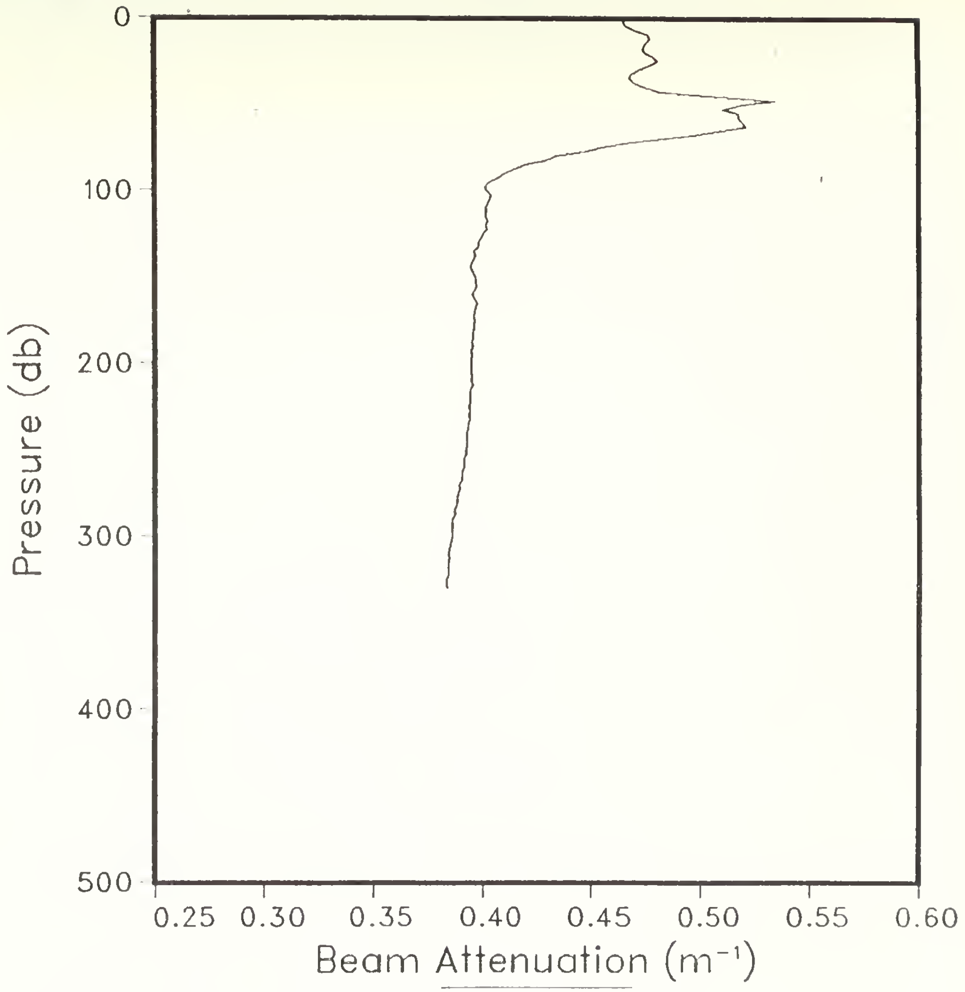


Latitude: 35.159°
Longitude: 124.868°

Date: 10/16/82
Time: 1825:08 GMT

R/V ACANIA CRUISE ODEX3 STATION 24

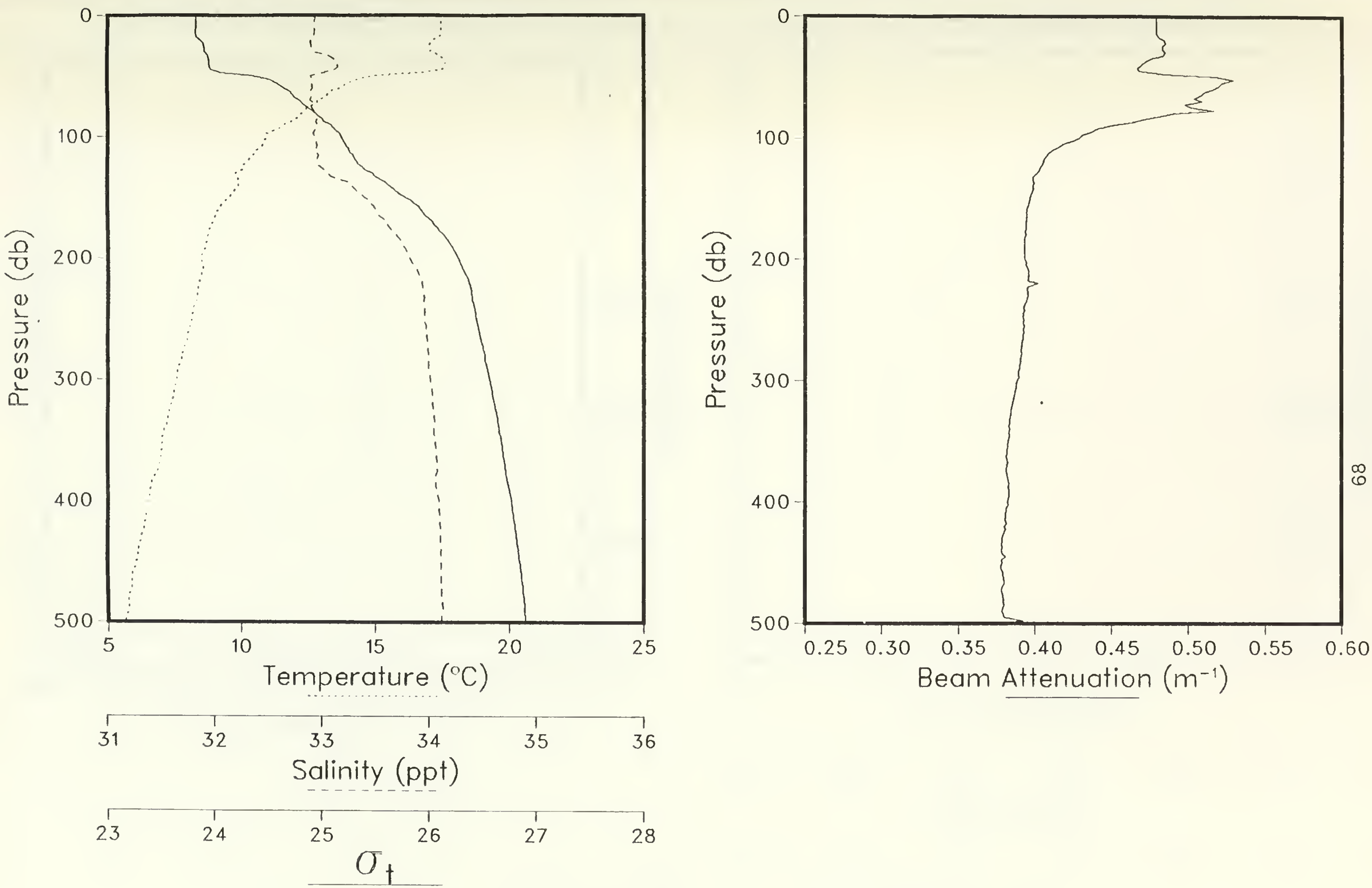




Latitude: 35.160°
Longitude: 124.710°

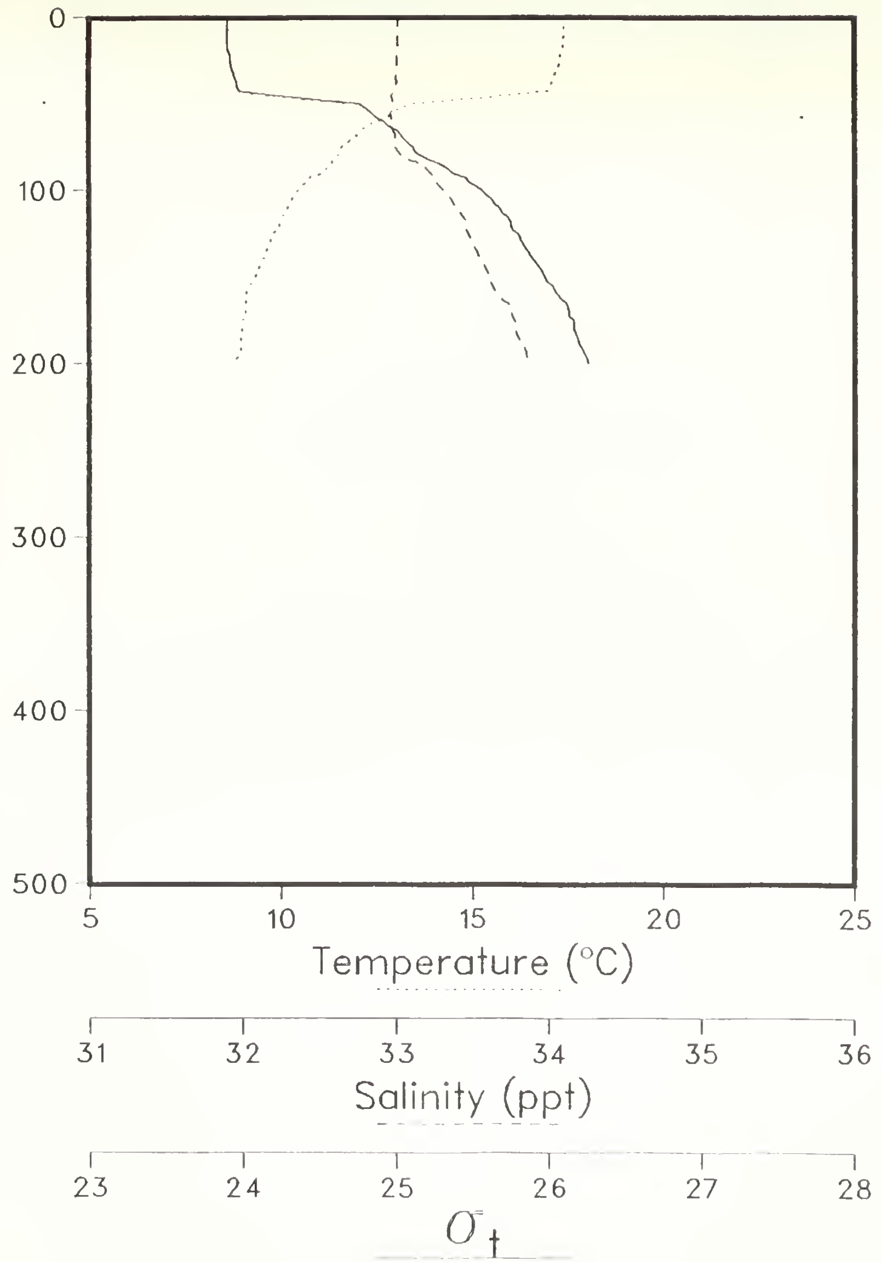
Date: 10/16/82
Time: 2154:19 GMT

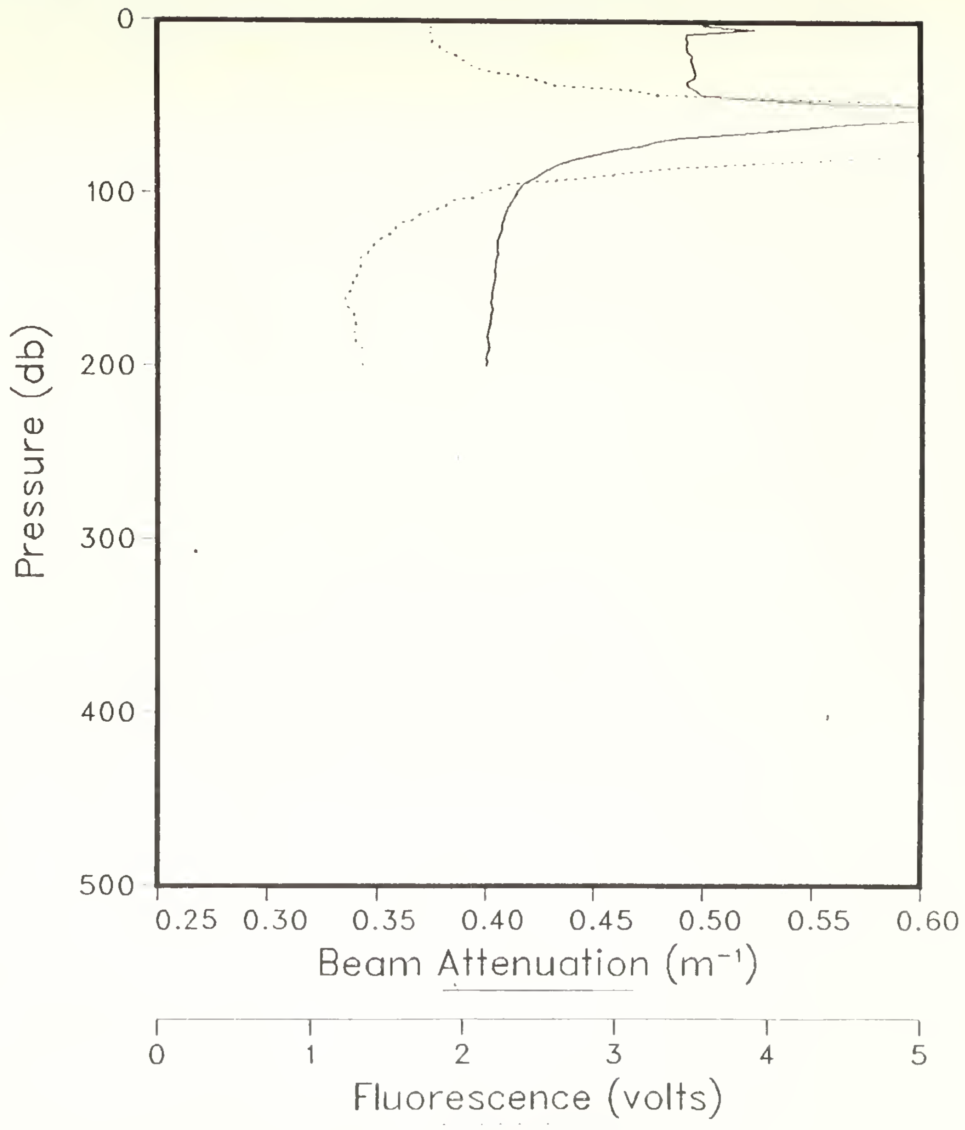
R/V ACANIA CRUISE ODEX3 STATION 25



Latitude: 35.158° Date: 10/17/82
Longitude: 124.535° Time: 58:09 GMT

R/V ACANIA CRUISE ODEX3 STATION 26

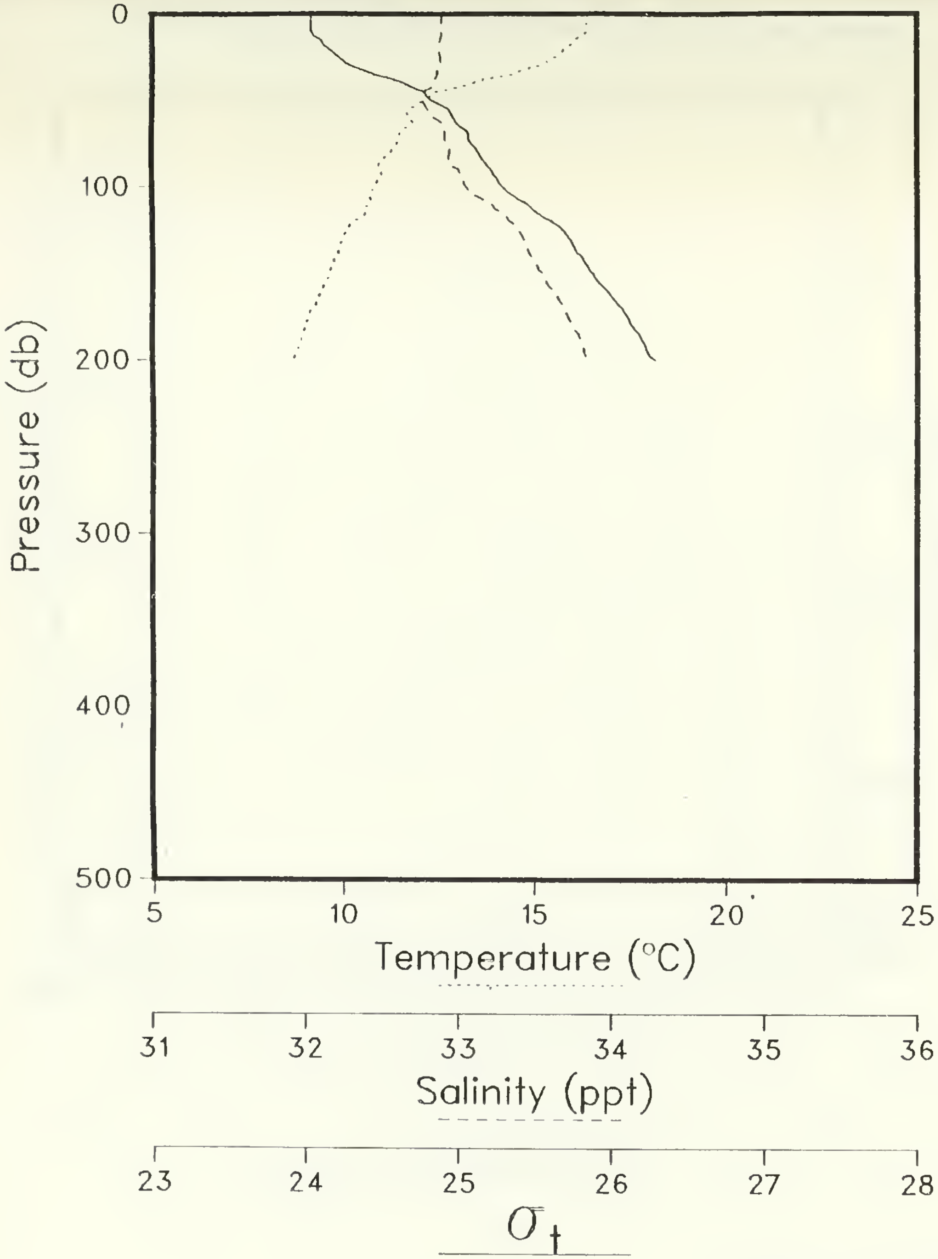


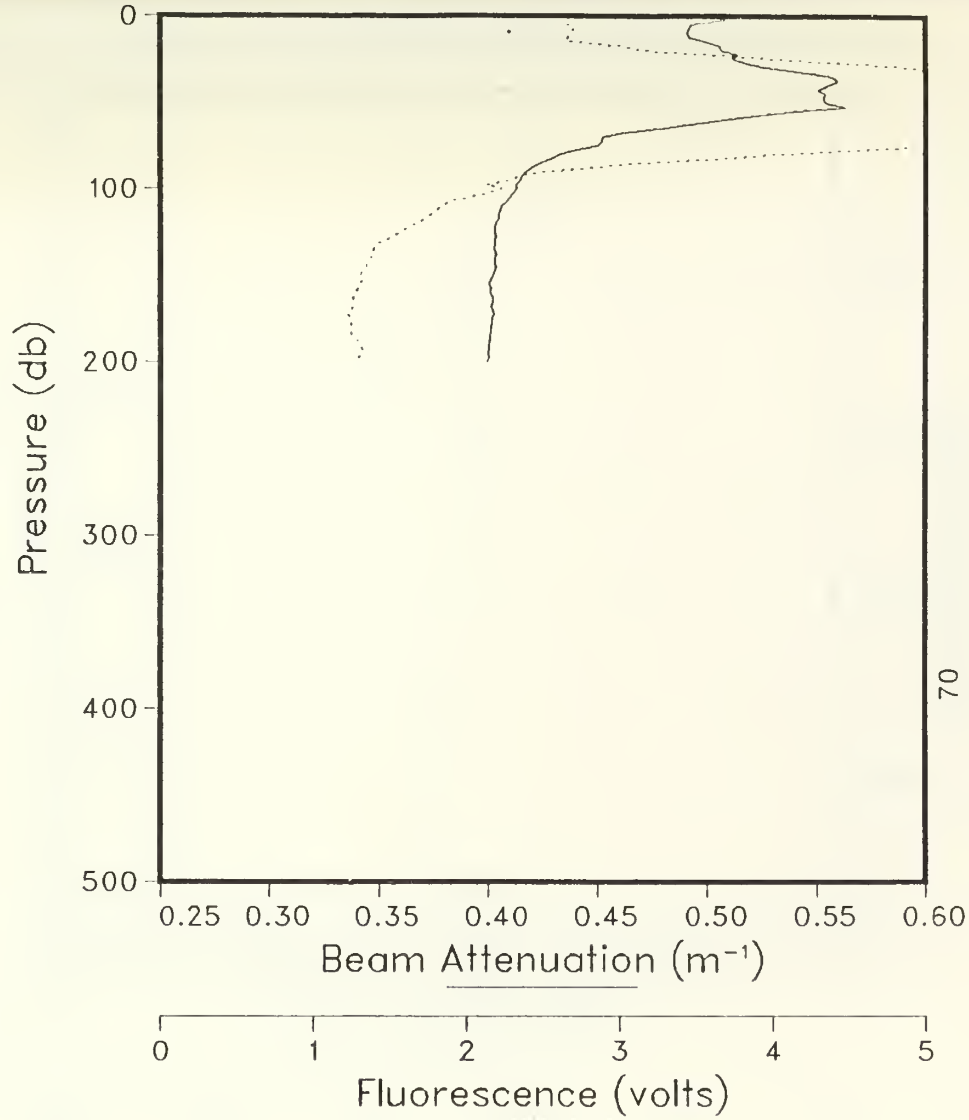


Latitude: 35.168°
Longitude: 124.020°

Date: 10/17/82
Time: 510:39 GMT

R/V ACANIA CRUISE ODEX3 STATION 27

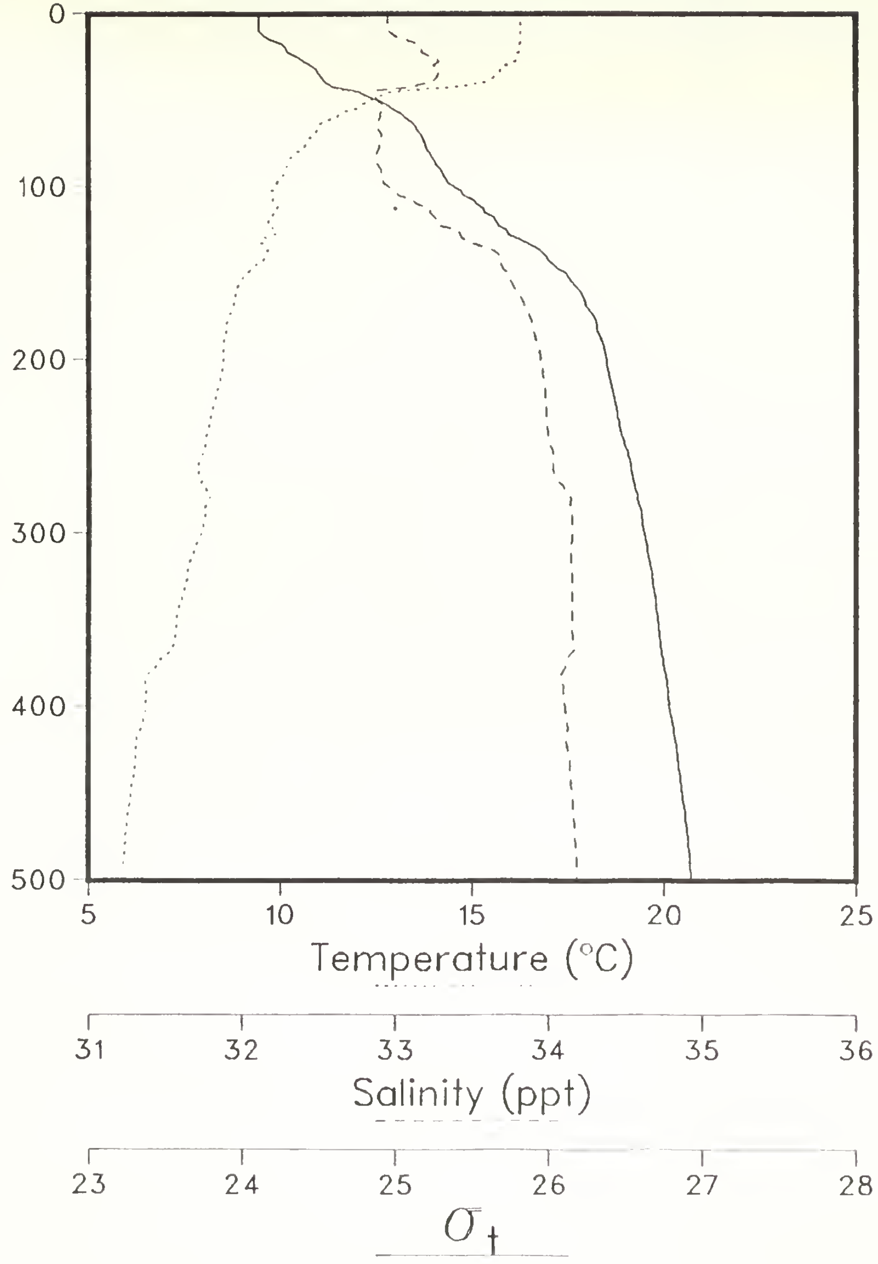


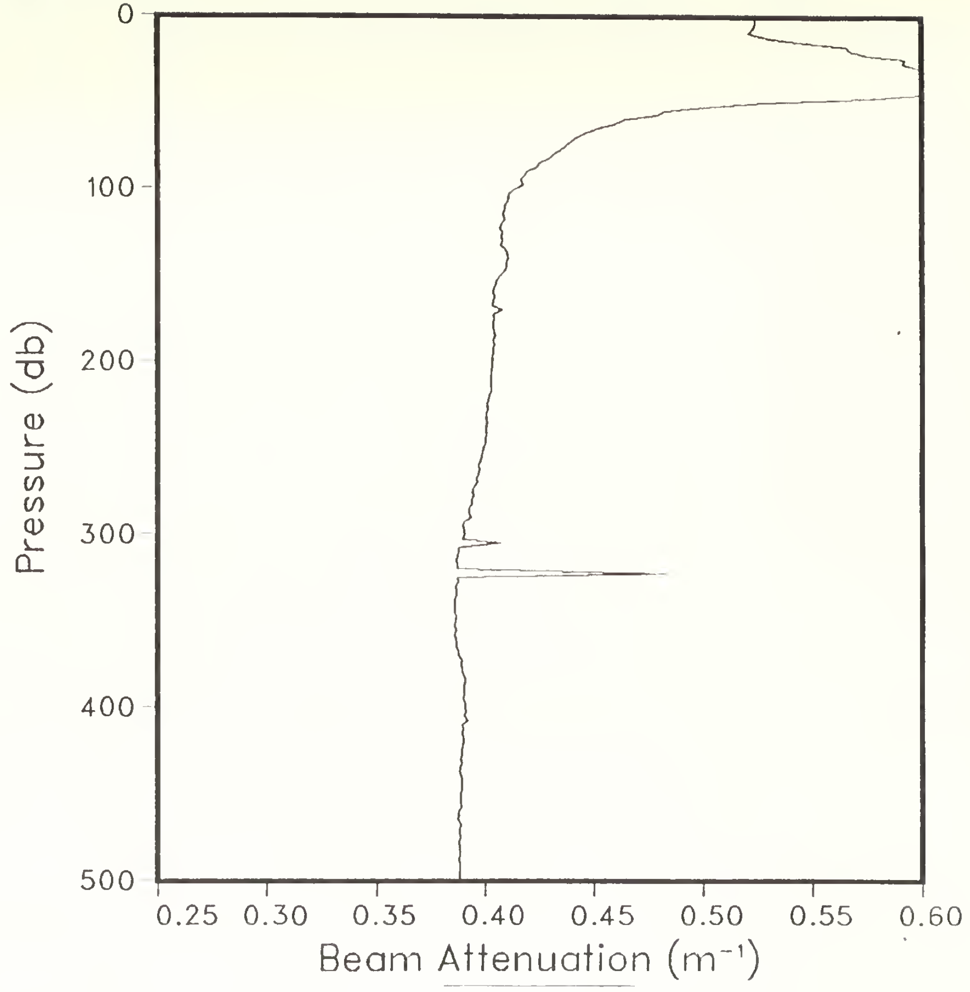


Latitude: 35.167°
Longitude: 123.489°

Date: 10/17/82
Time: 907:47 GMT

R/V ACANIA CRUISE ODEX3 STATION 28

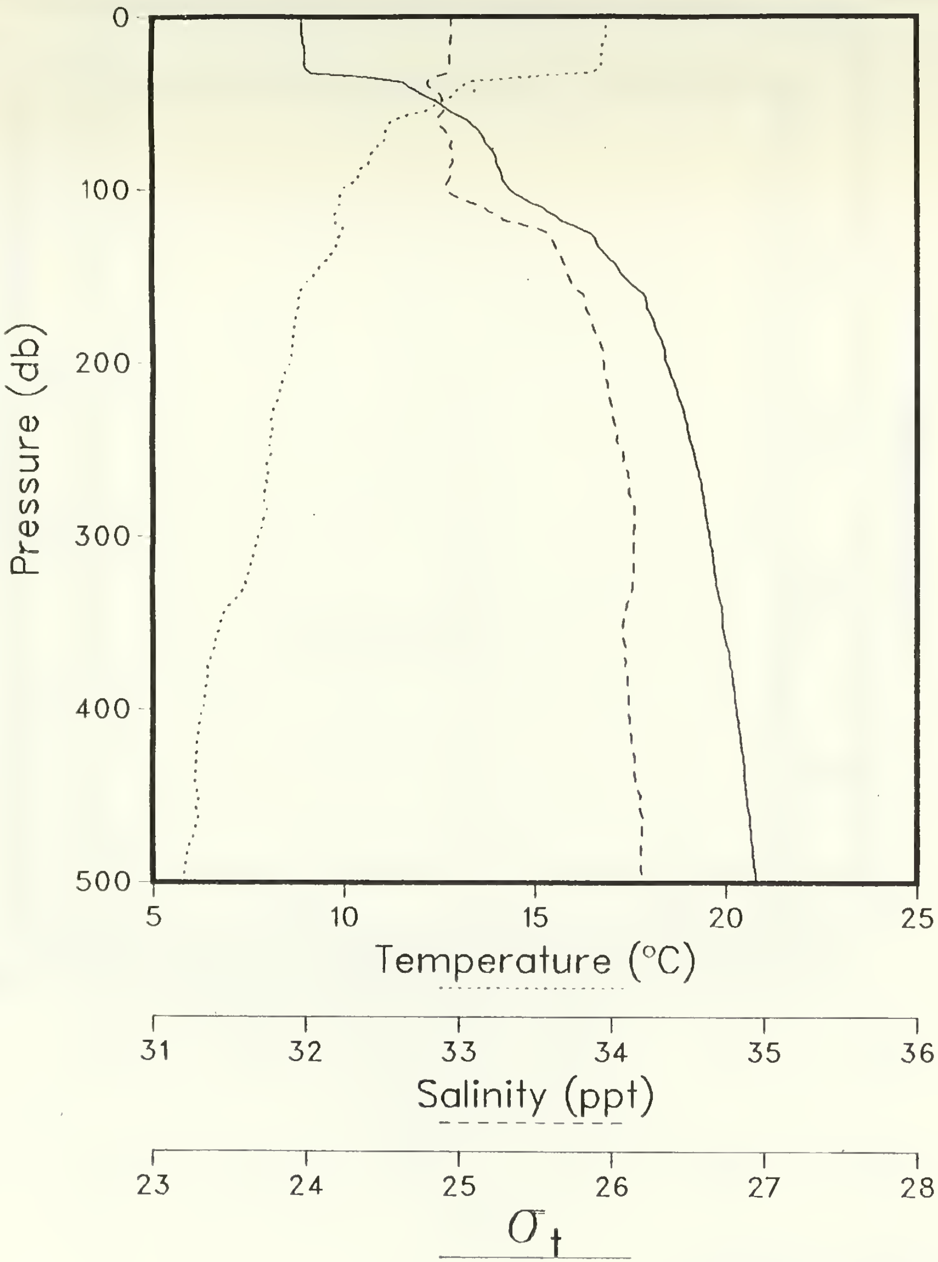


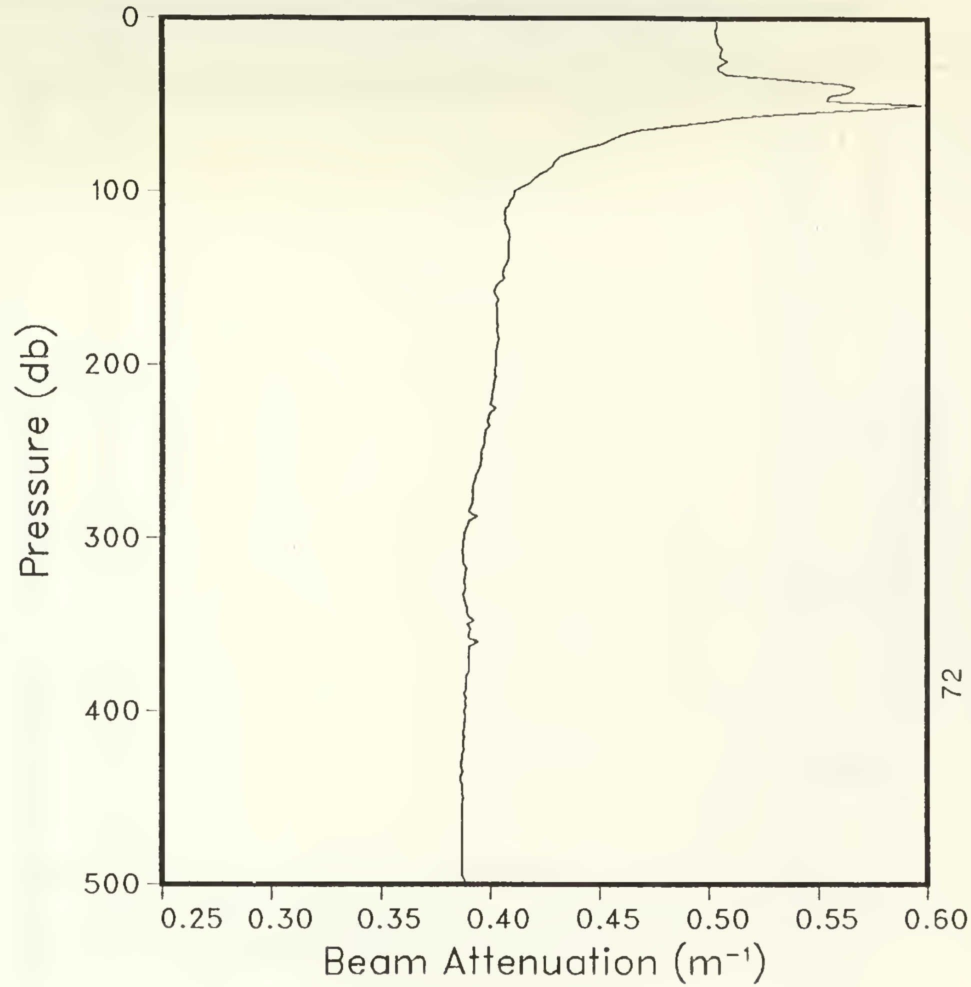


Latitude: 34.487°
Longitude: 123.501°

Date: 10/17/82
Time: 1510:43 GMT

R/V ACANIA CRUISE ODEX3 STATION 29

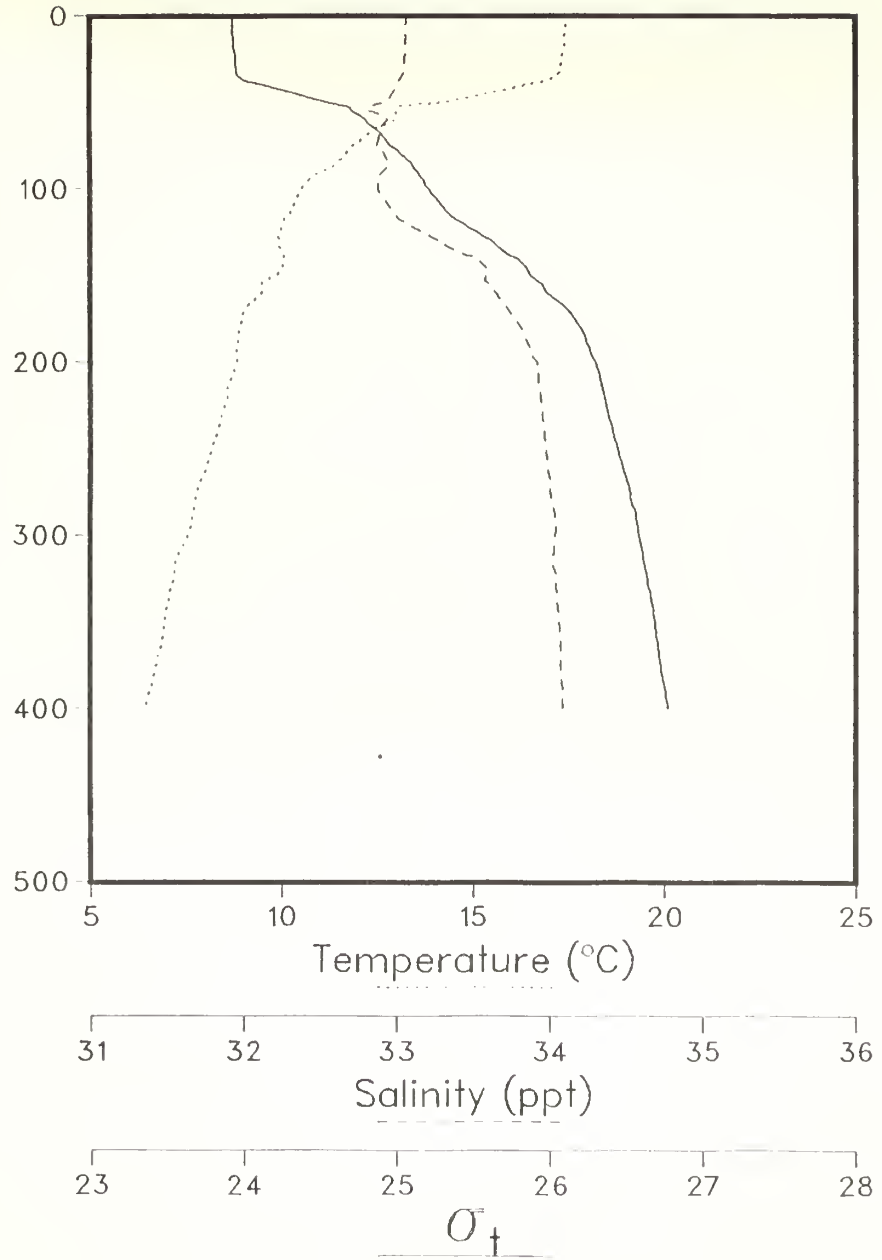


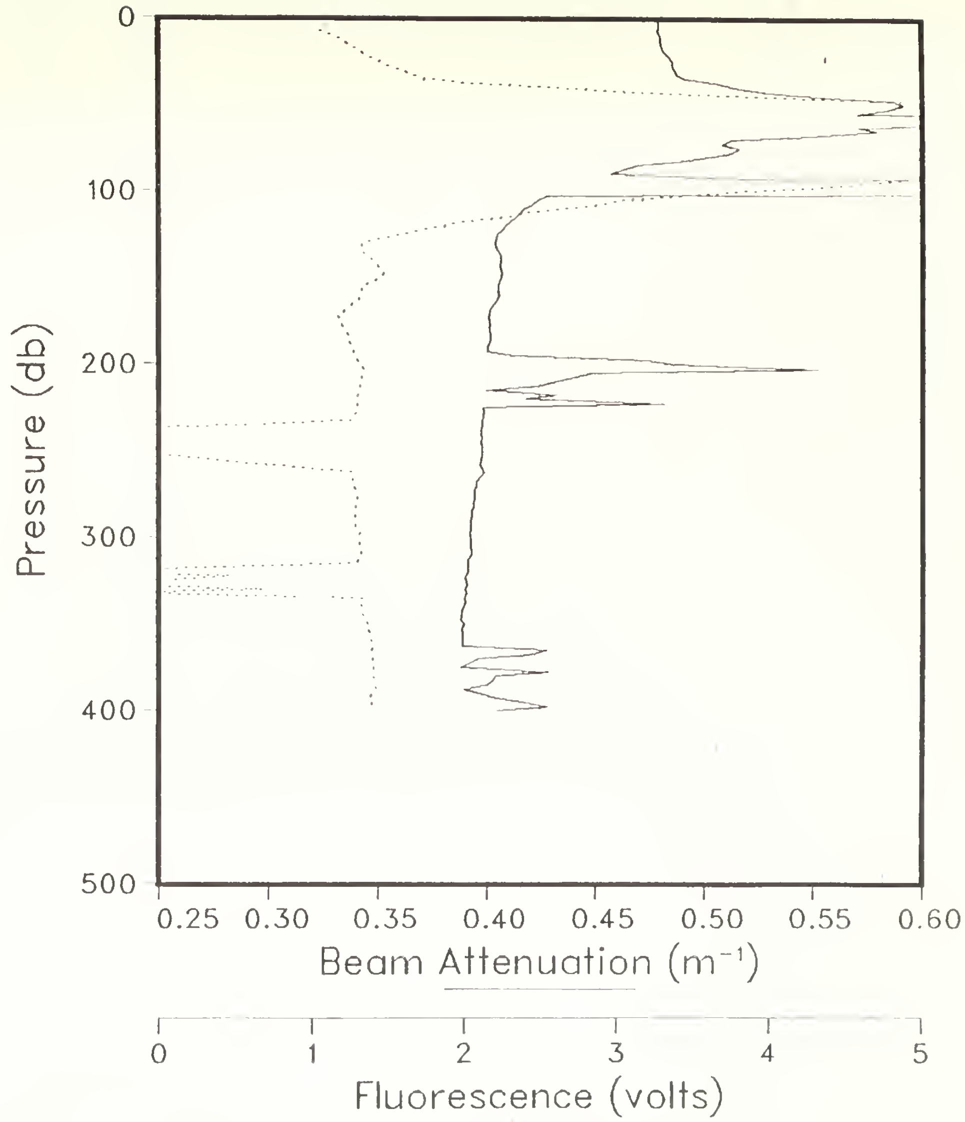


Latitude: 34.470° Longitude: 123.674°

Date: 10/17/82 Time: 1917:08 GMT

R/V ACANIA CRUISE ODEX3 STATION 30

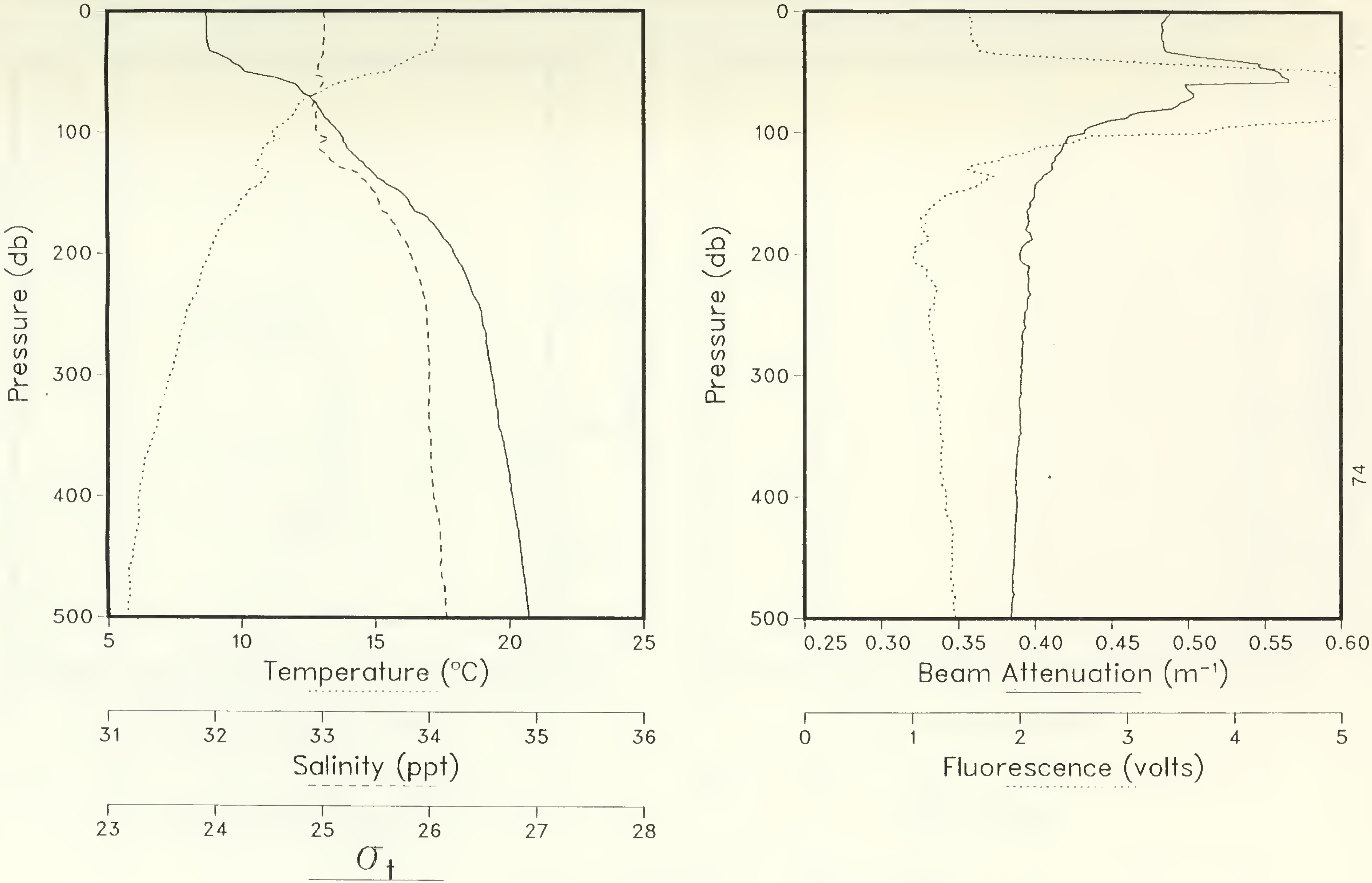




Latitude: 34.483°
Longitude: 123.827°

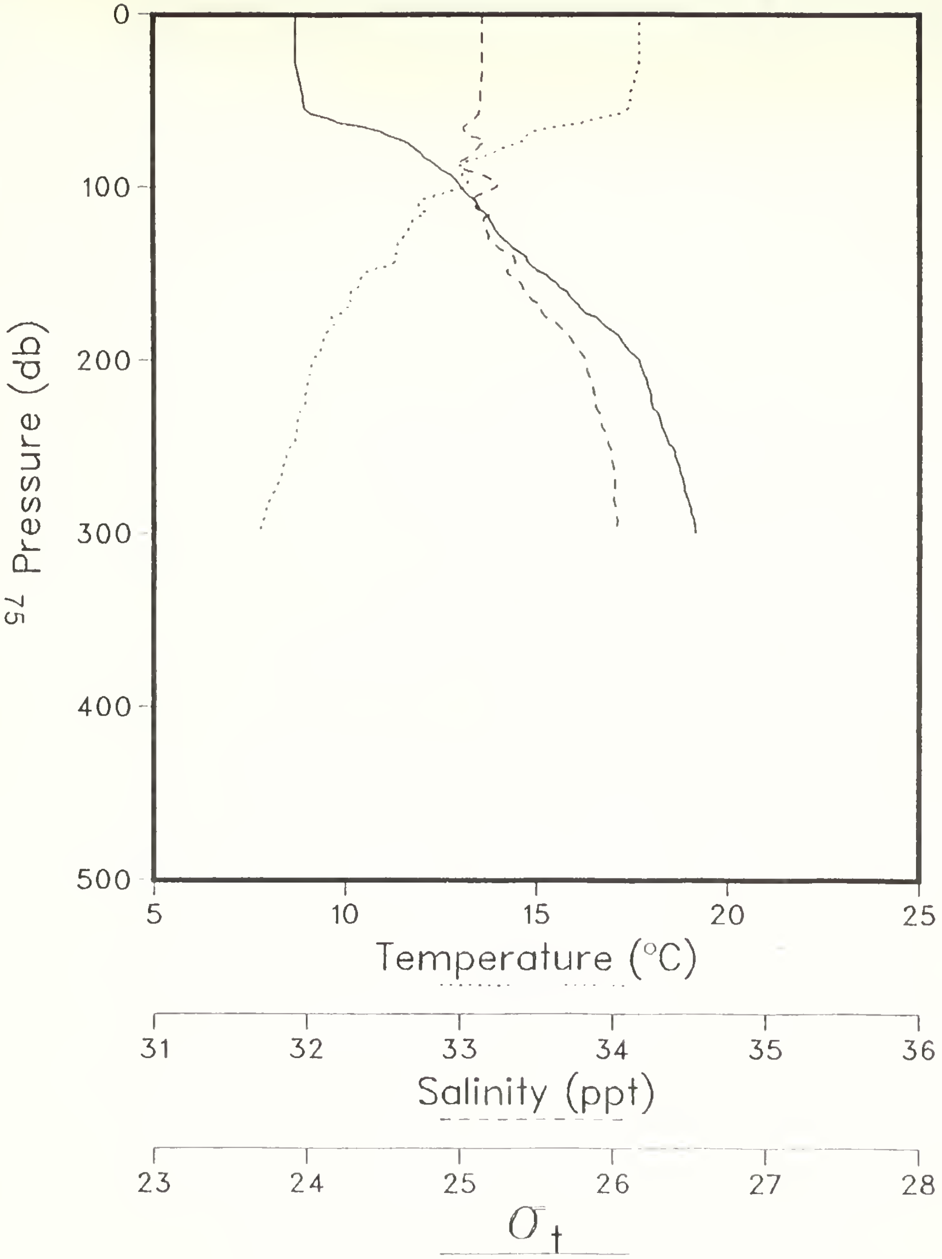
Date: 10/17/82
Time: 2219:21 GMT

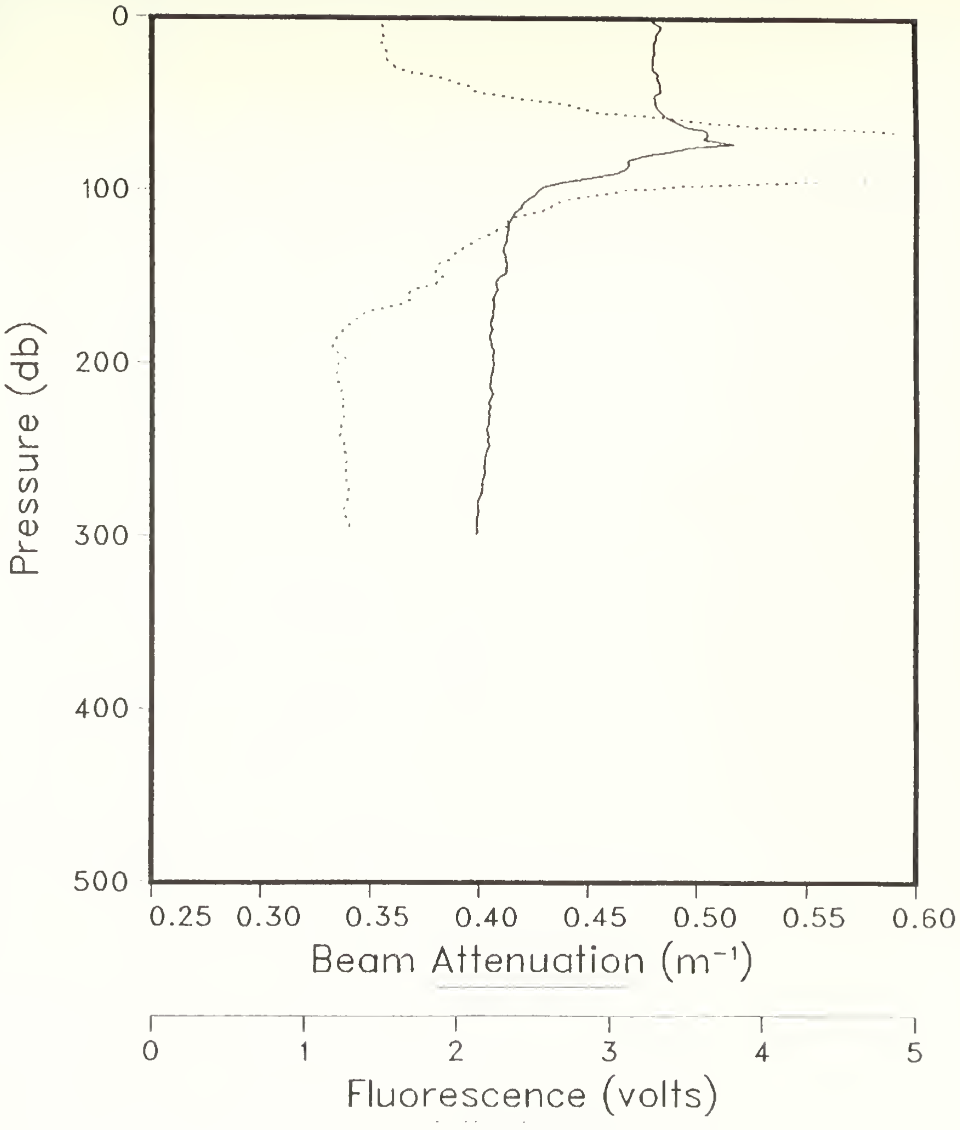
R/V ACANIA CRUISE ODEX3 STATION 31



Latitude: 34.483° Date: 10/18/82
Longitude: 123.987° Time: 102:41 GMT

R/V ACANIA CRUISE ODEX3 STATION 32

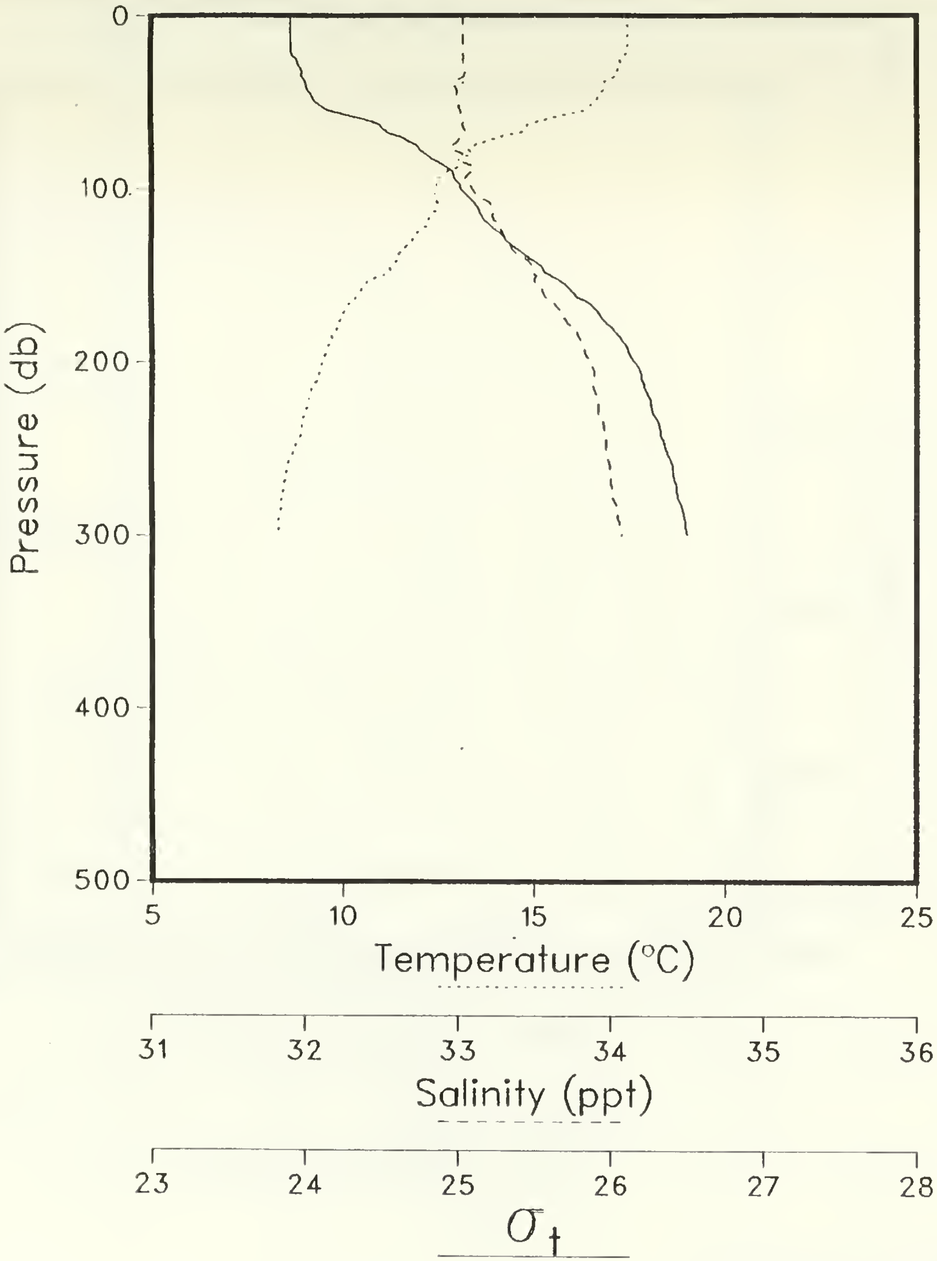


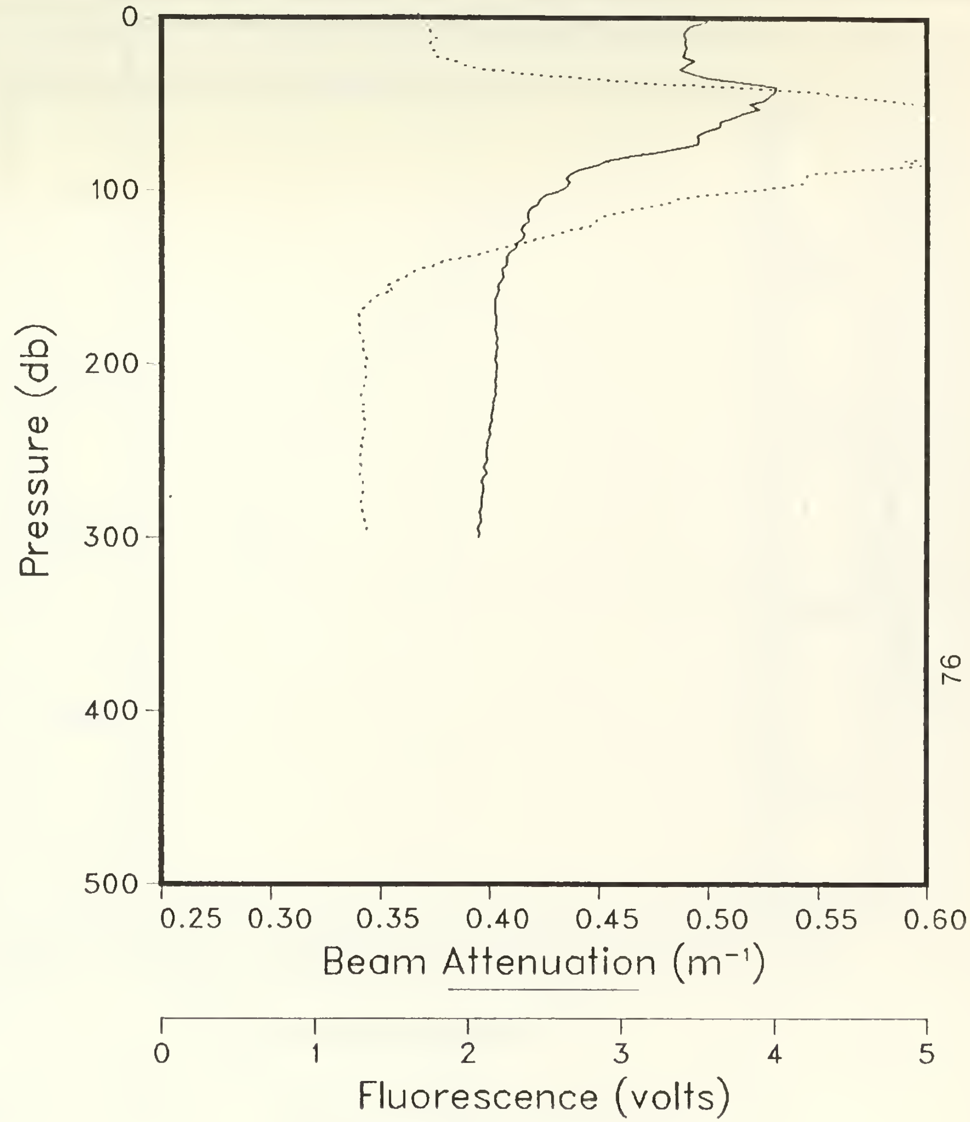


Latitude: 34.501°
Longitude: 124.371°

Date: 10/18/82
Time: 436:25 GMT

R/V ACANIA CRUISE ODEX3 STATION 33

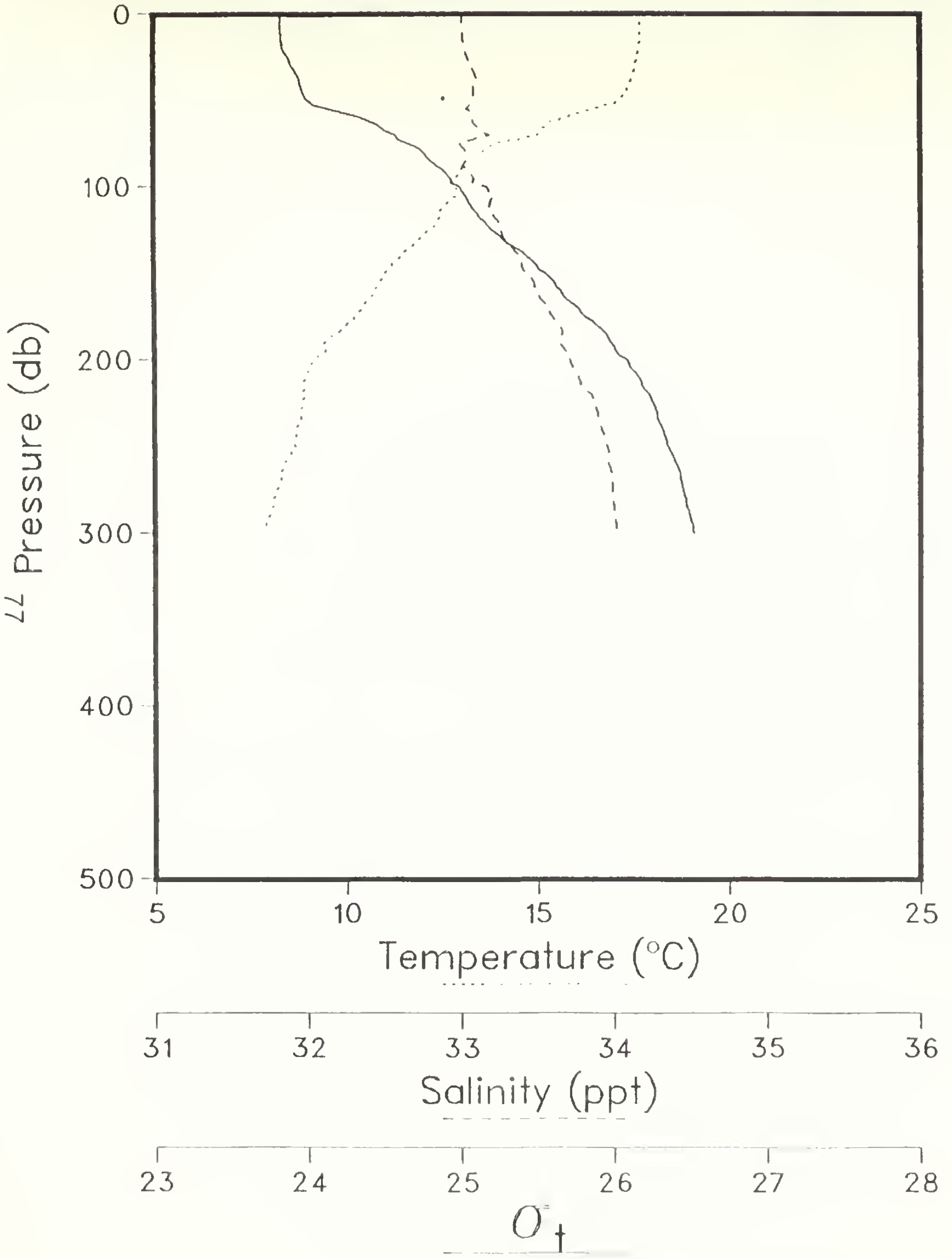


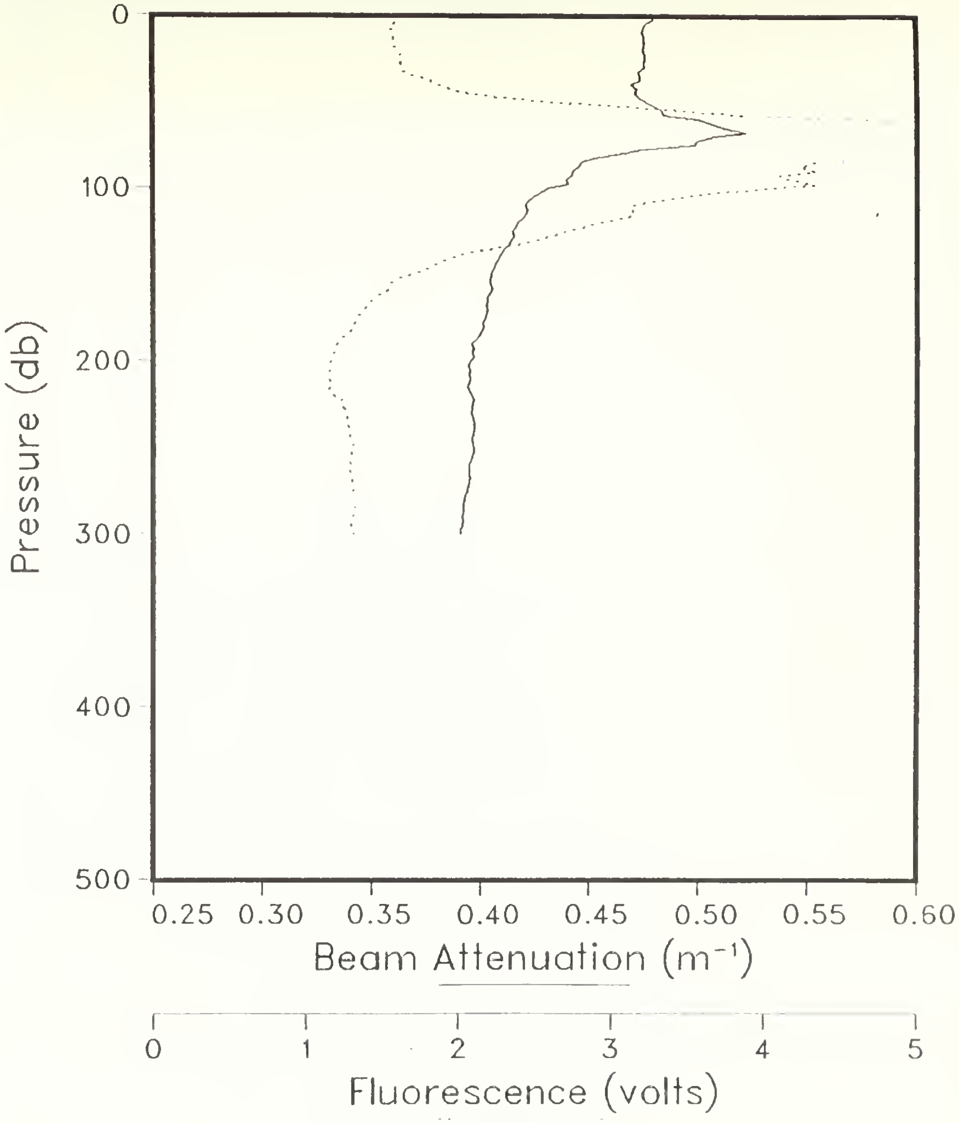


Latitude: 34.497°
Longitude: 124.798°

Date: 10/18/82
Time: 816:52 GMT

R/V ACANIA CRUISE ODEX3 STATION 34

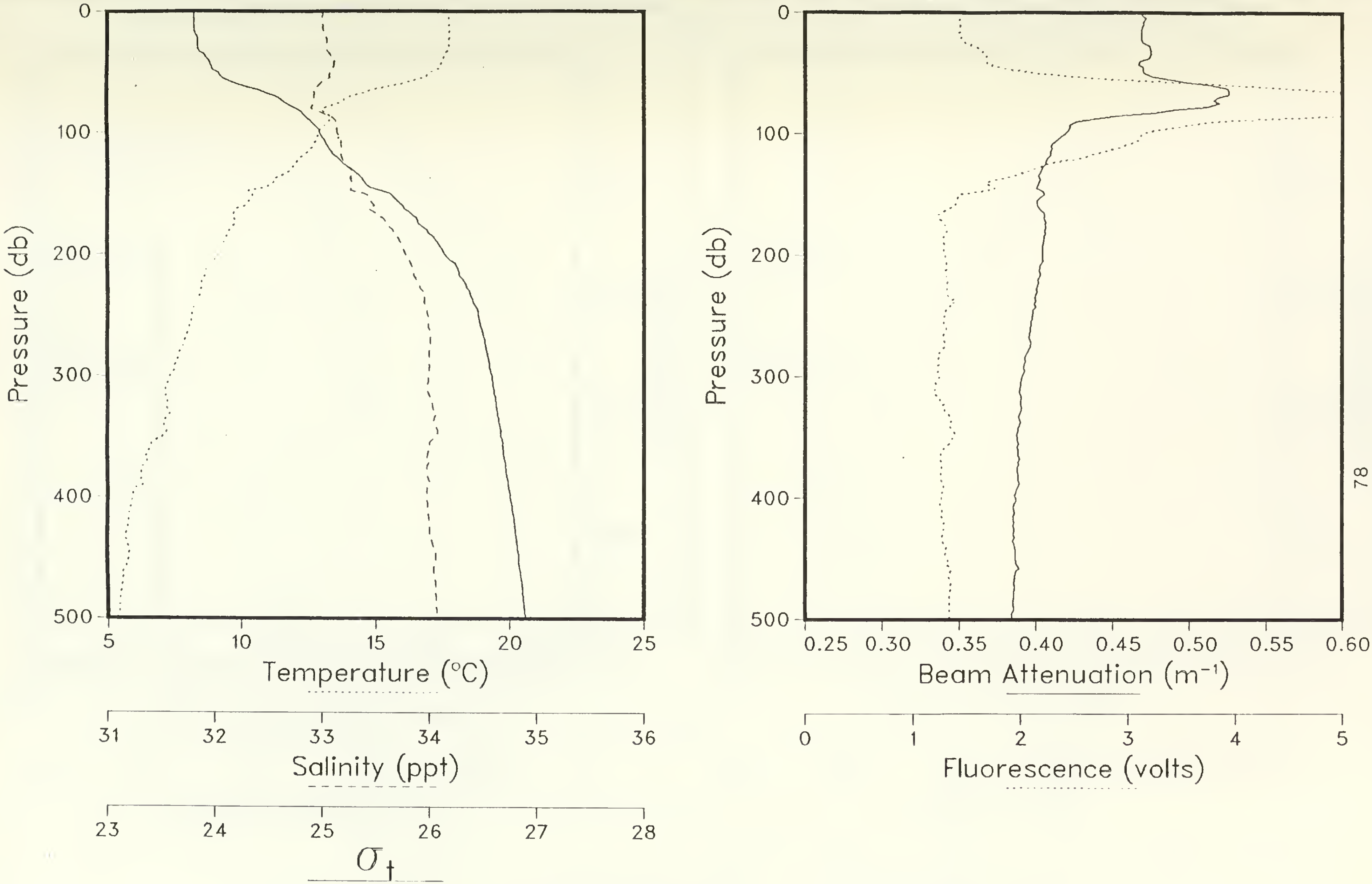




Latitude: 34.495°
Longitude: 125.160°

Date: 10/18/82
Time: 1140:43 GMT

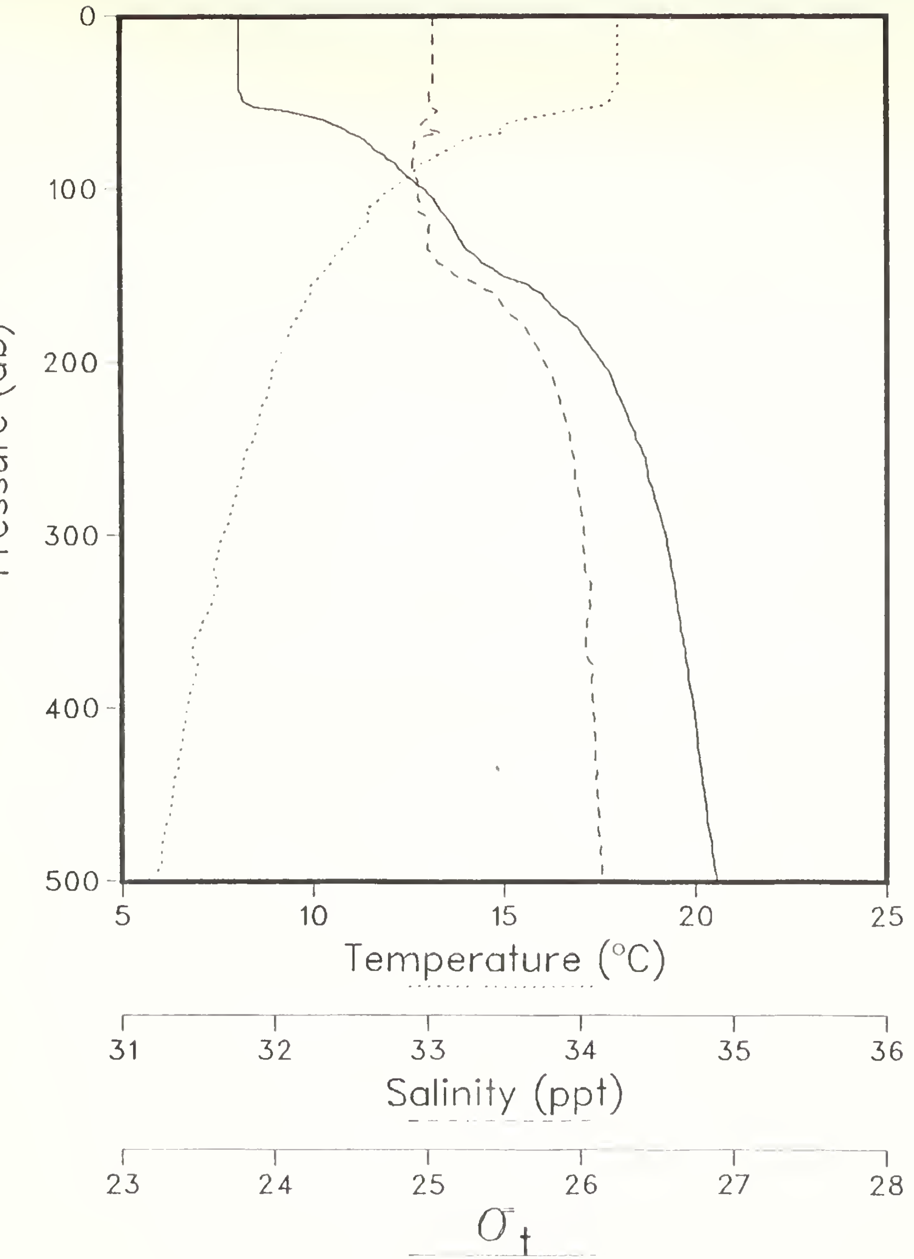
R/V ACANIA CRUISE ODEX3 STATION 35

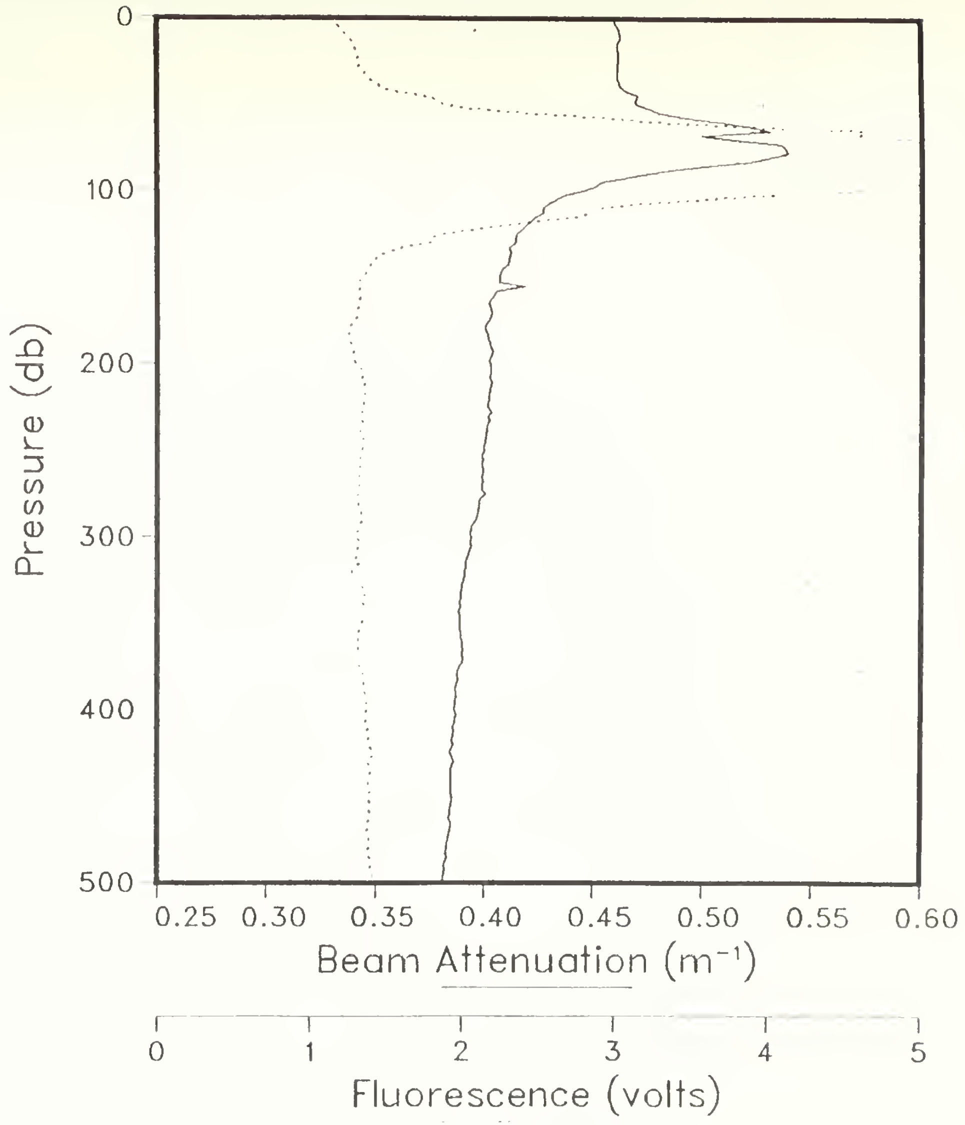


Latitude: 34.500° Longitude: 125.552°

Date: 10/18/82 Time: 1508:08 GMT

R/V ACANIA CRUISE ODEX3 STATION 36

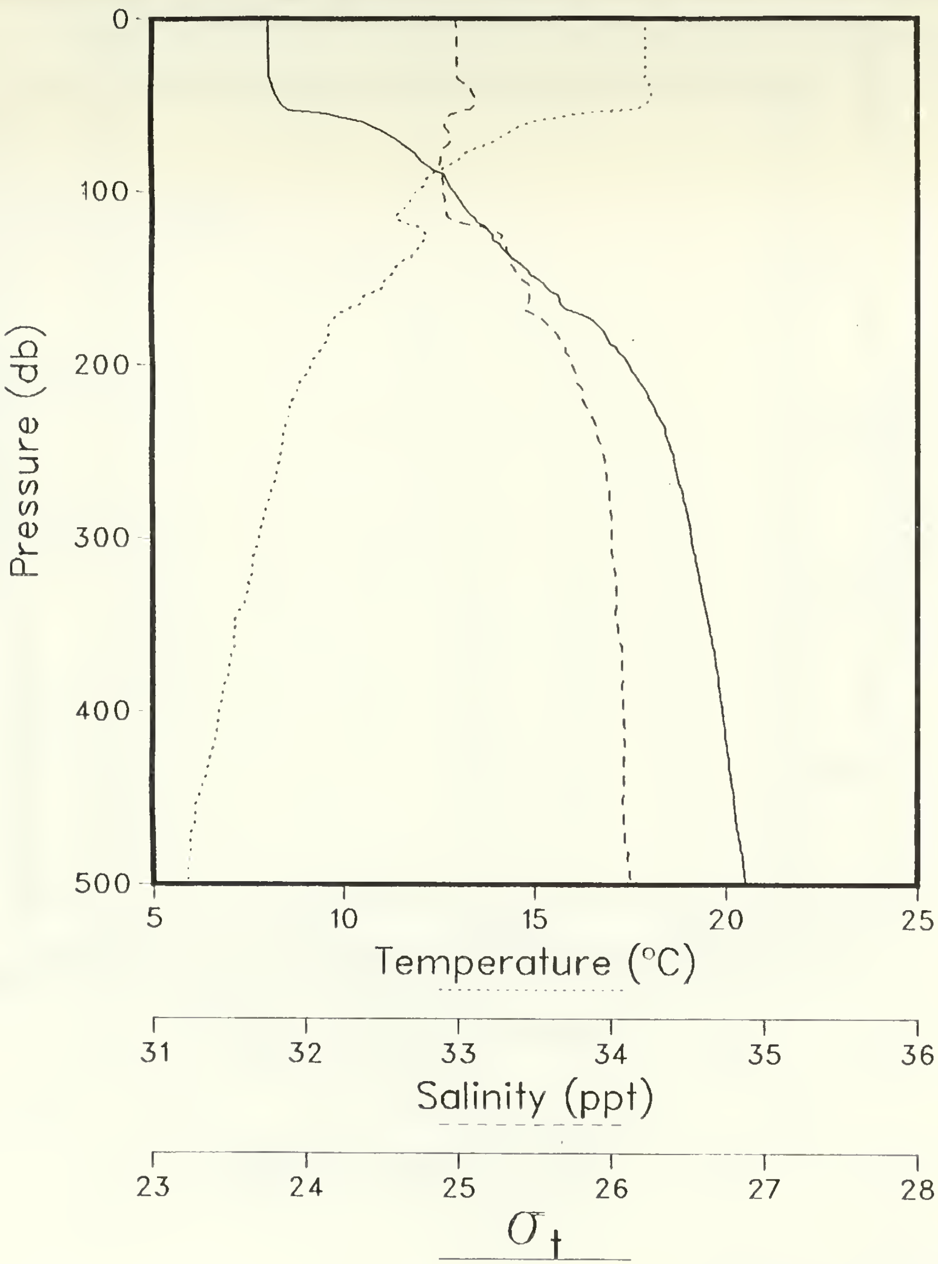


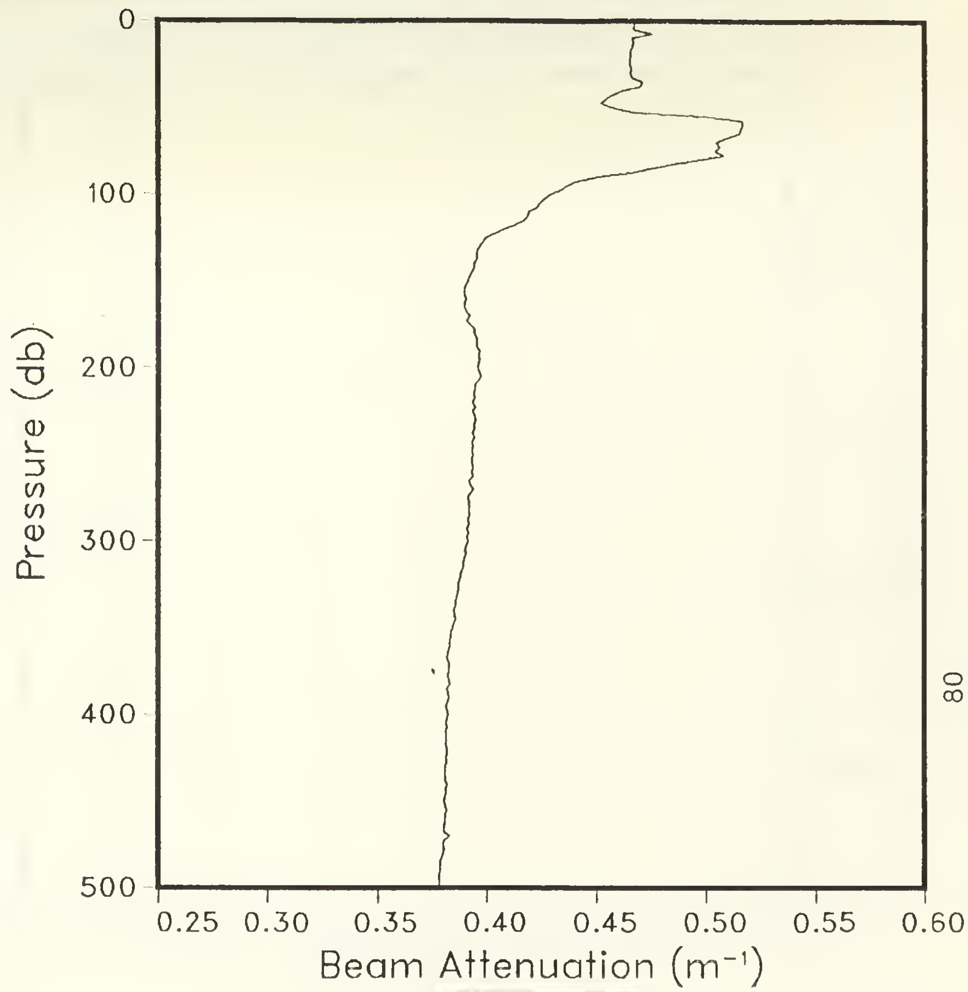


Latitude: 34.496°
Longitude: 125.682°

Date: 10/18/82
Time: 1742:06 GMT

R/V ACANIA CRUISE ODEX3 STATION 37

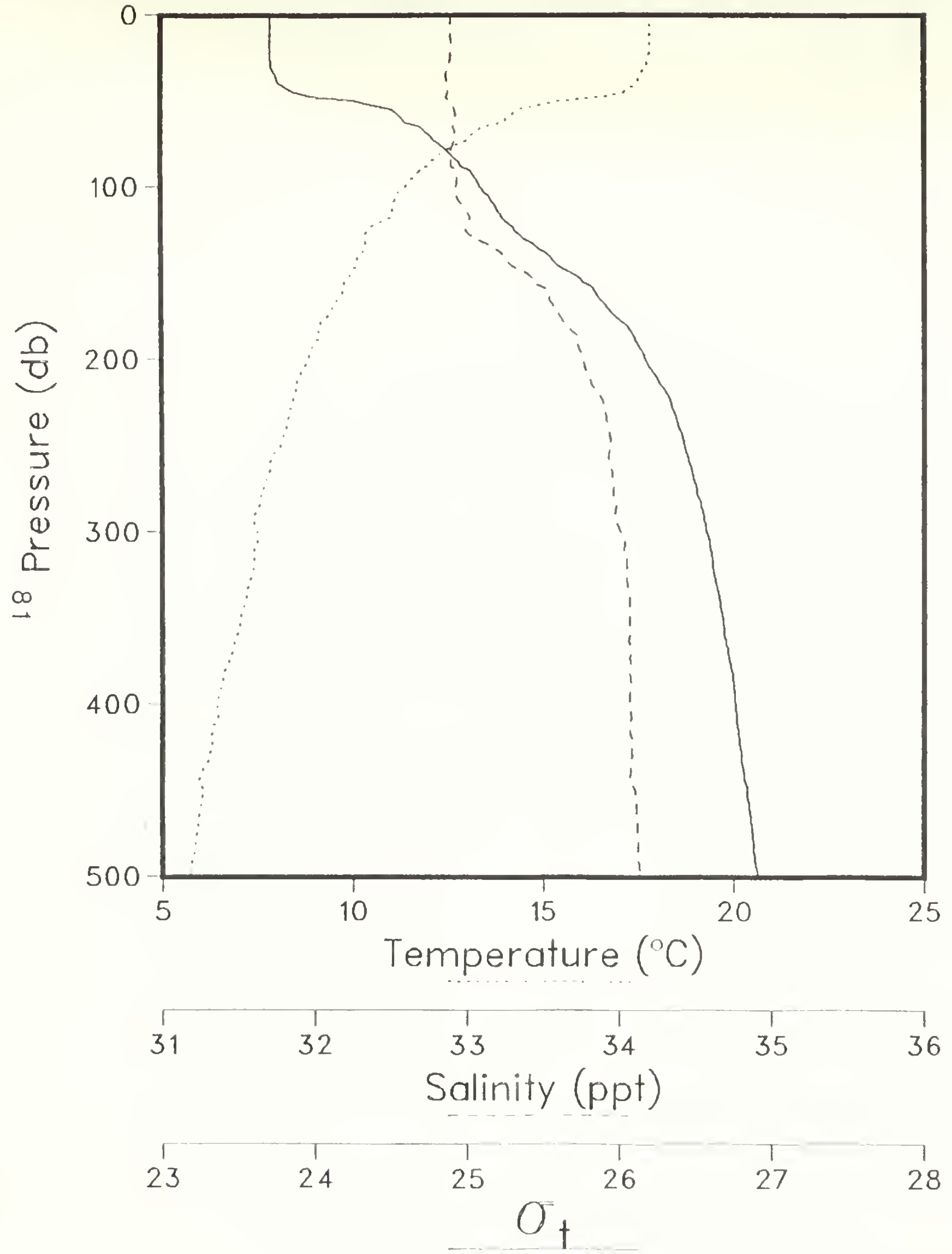


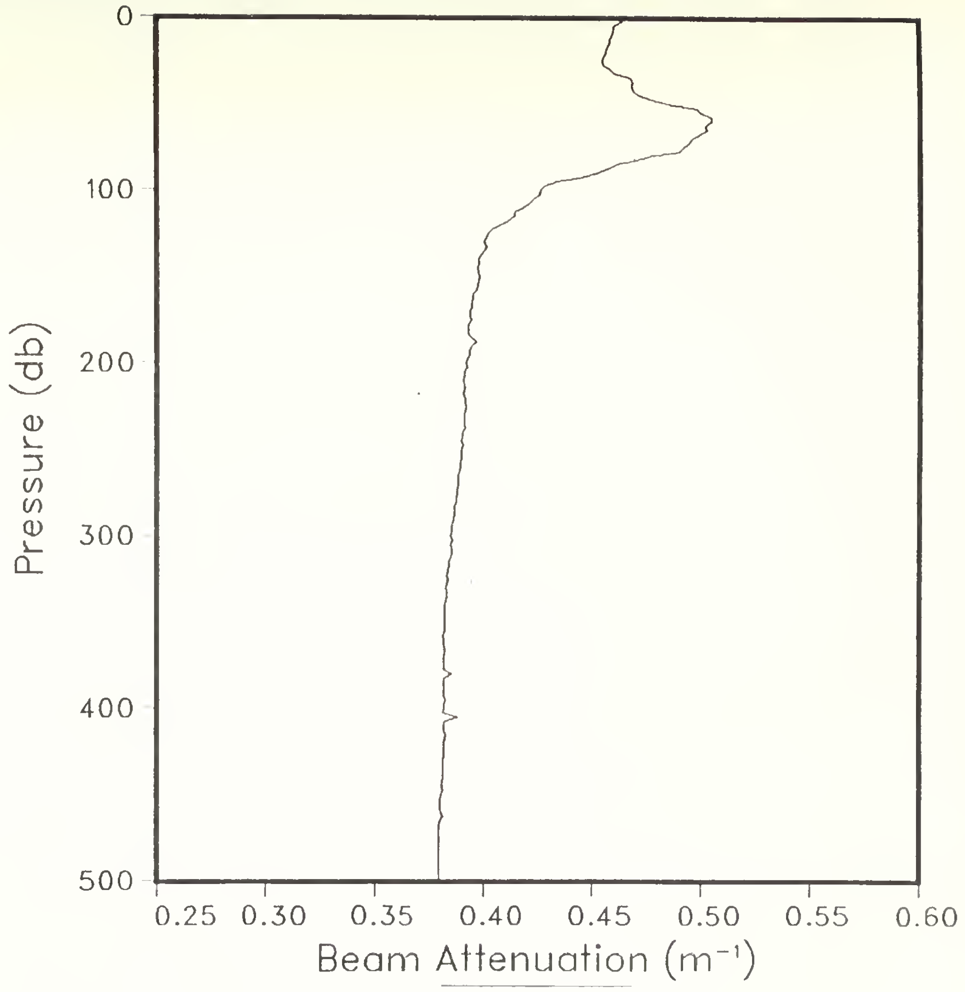


Latitude: 34.500°
Longitude: 125.758°

Date: 10/18/82
Time: 2206:09 GMT

R/V ACANIA CRUISE ODEX3 STATION 38

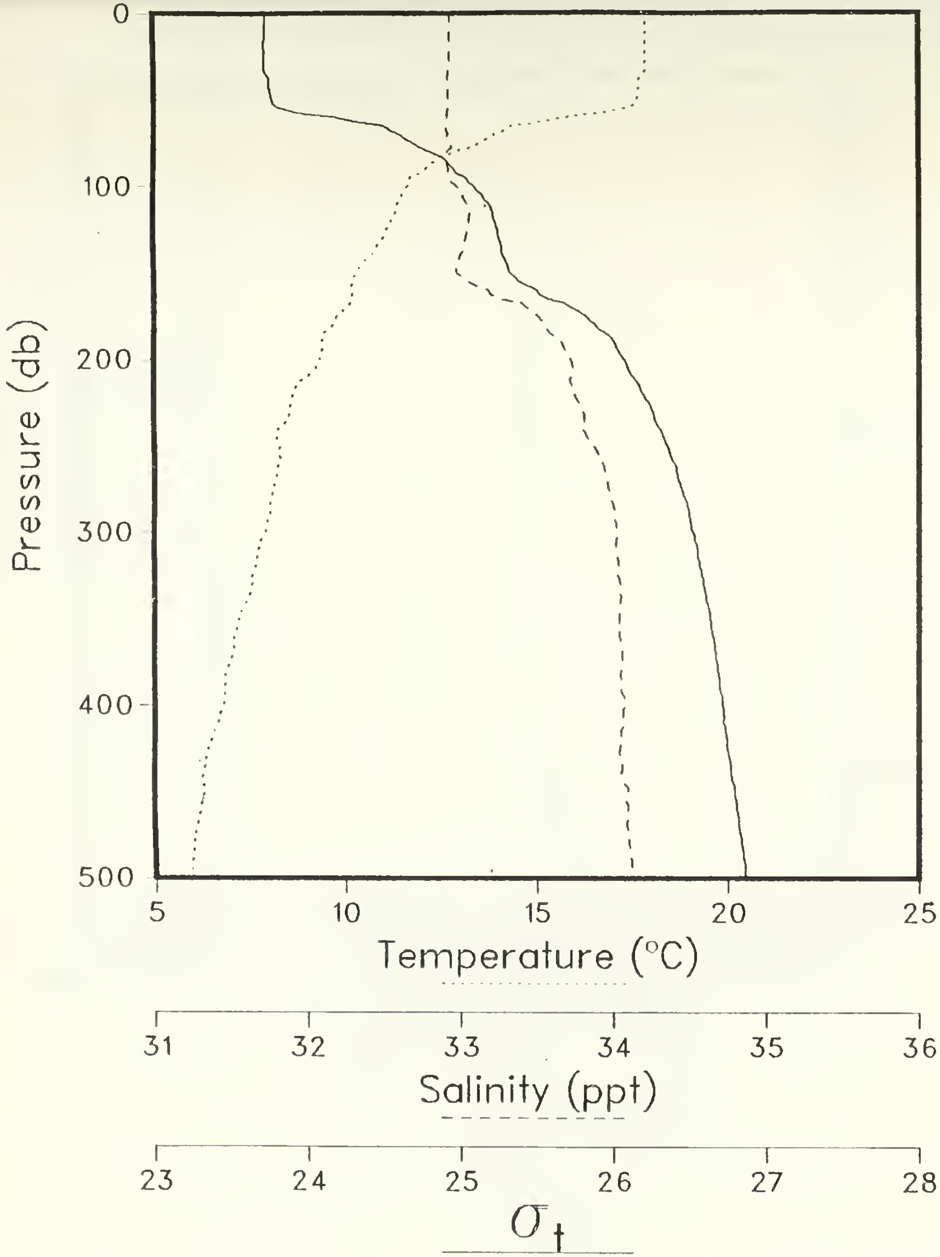


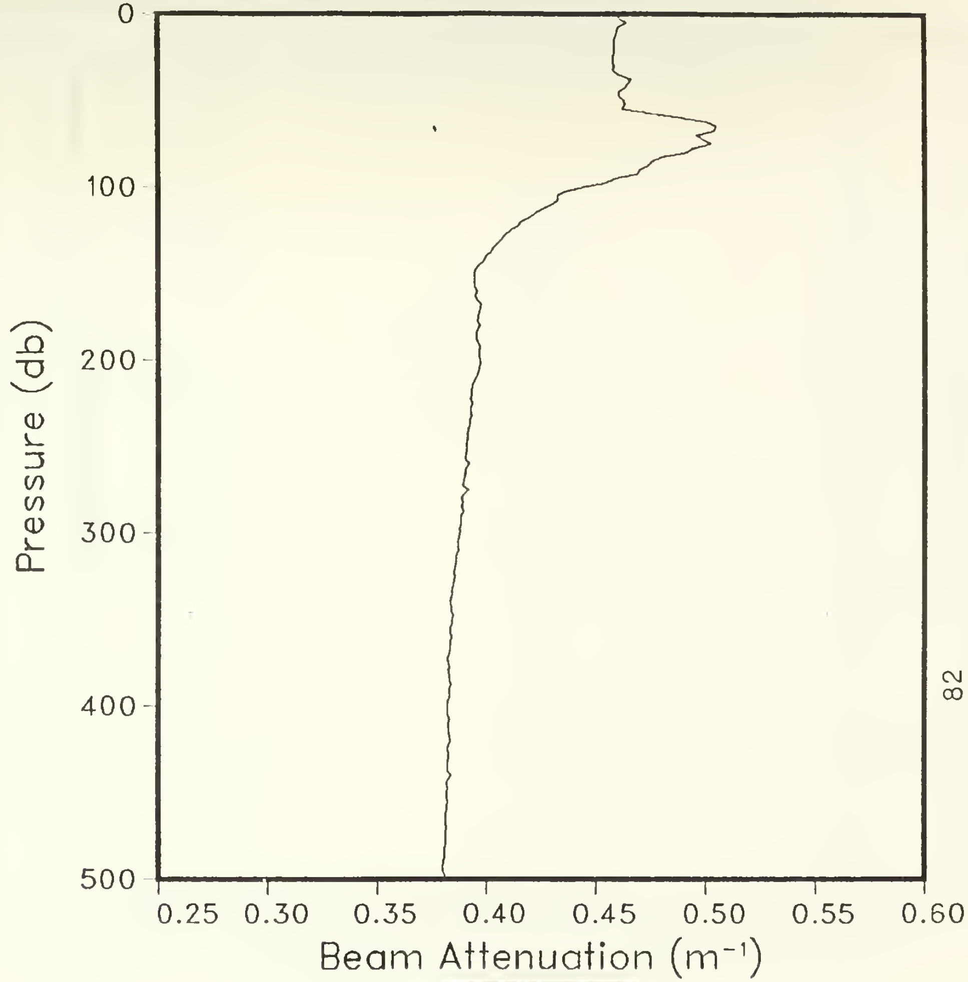


Latitude: 34.493°
Longitude: 125.917°

Date: 10/19/82
Time: 41:38 GMT

R/V ACANIA CRUISE ODEX3 STATION 39

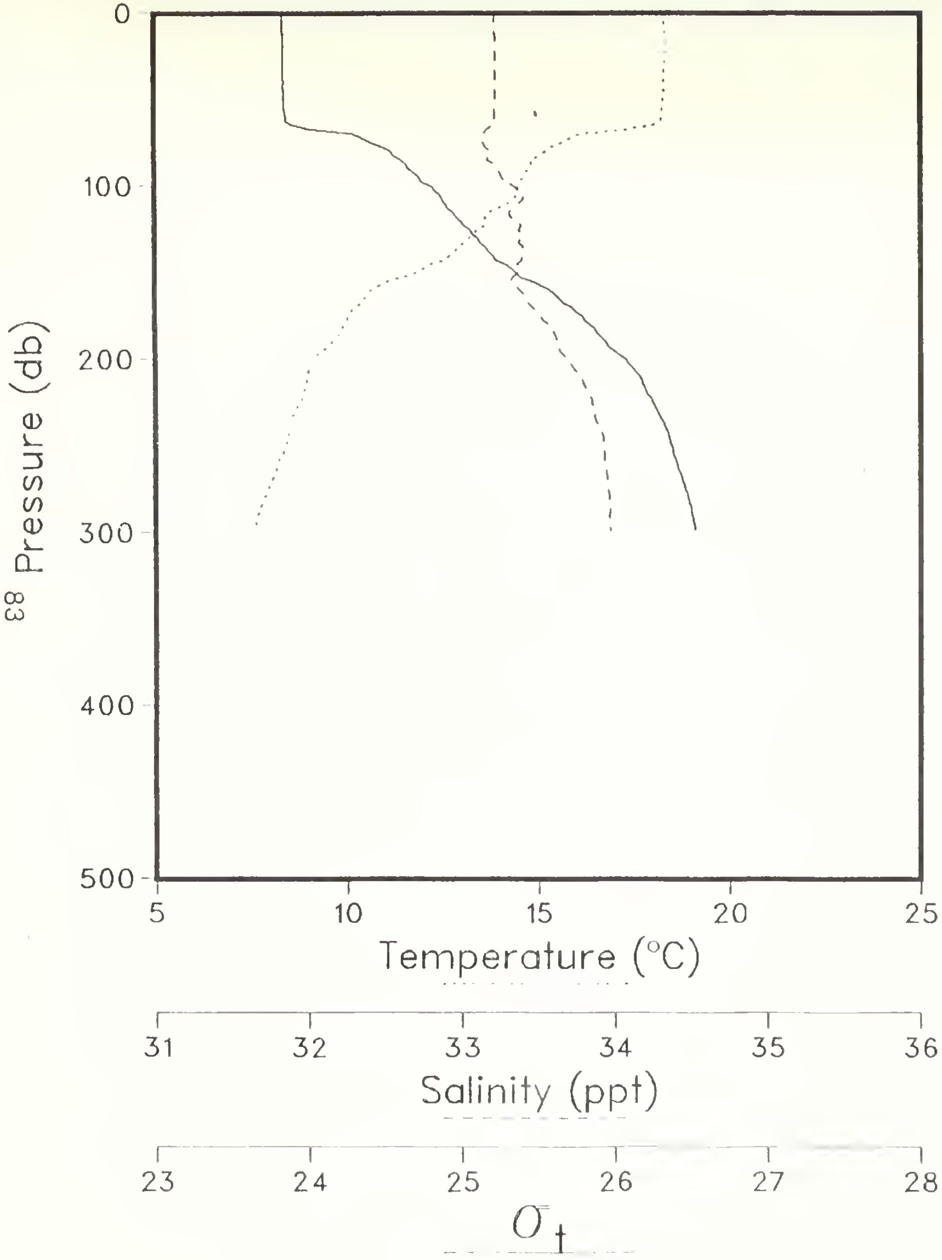


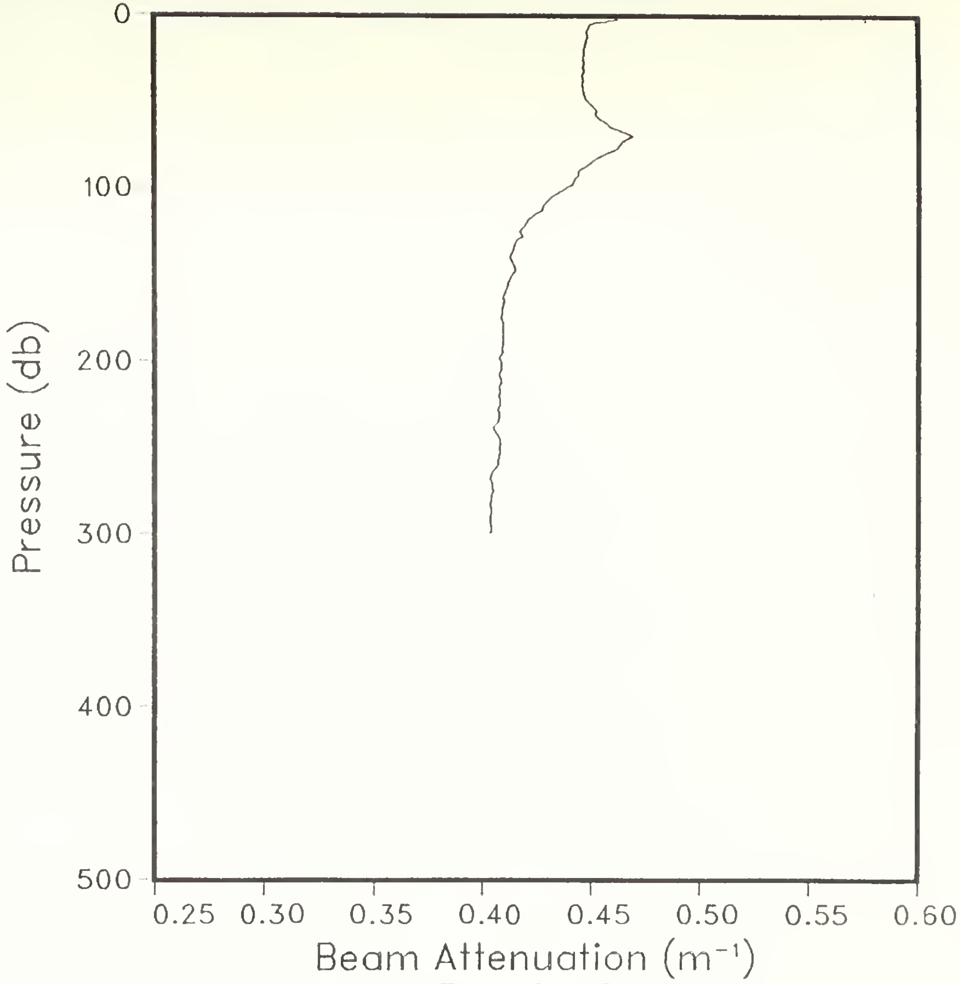


Latitude: 34.498° Longitude: 126.380°

Date: 10/19/82 Time: 436:30 GMT

R/V ACANIA CRUISE ODEX3 STATION 40

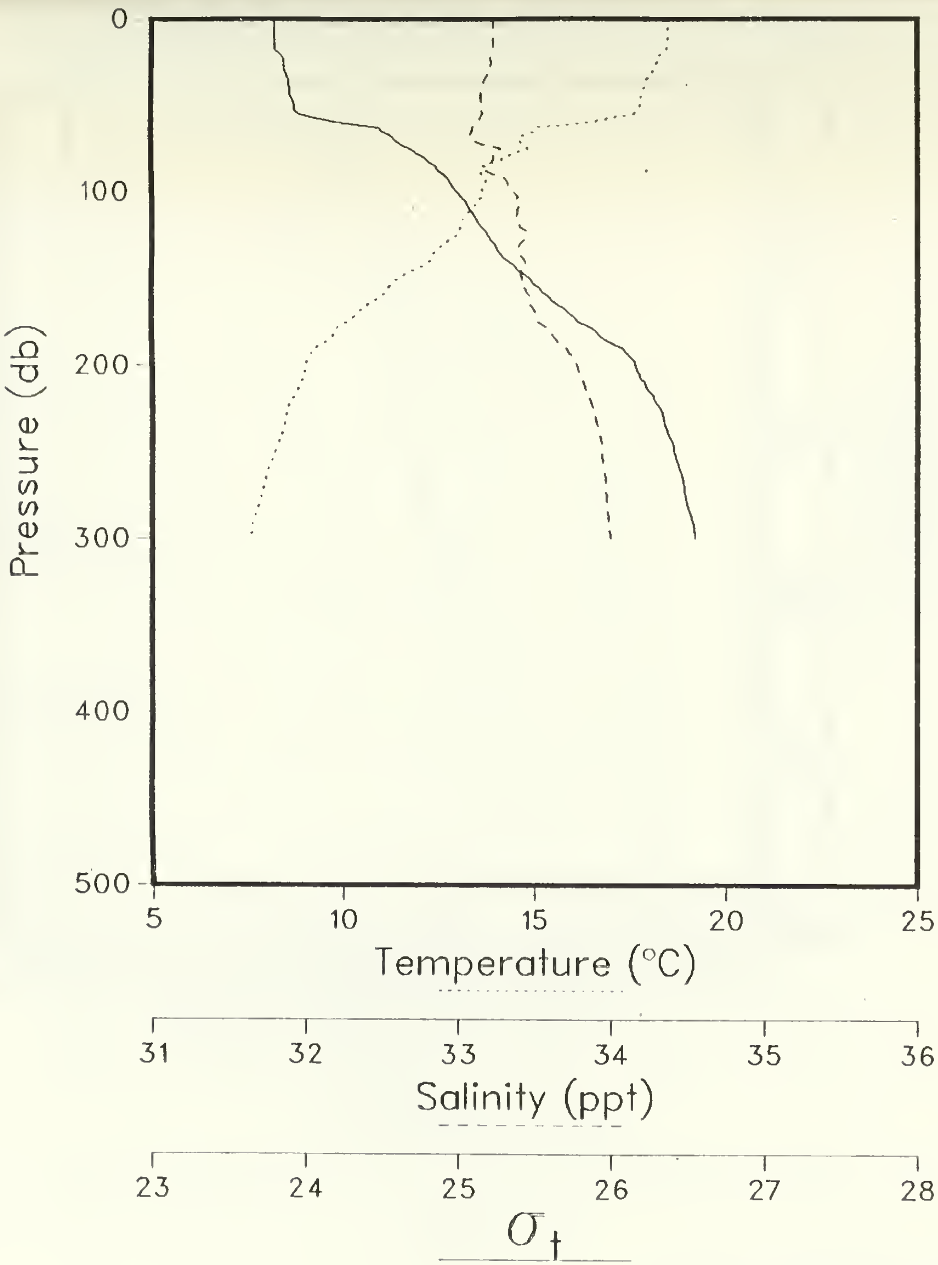


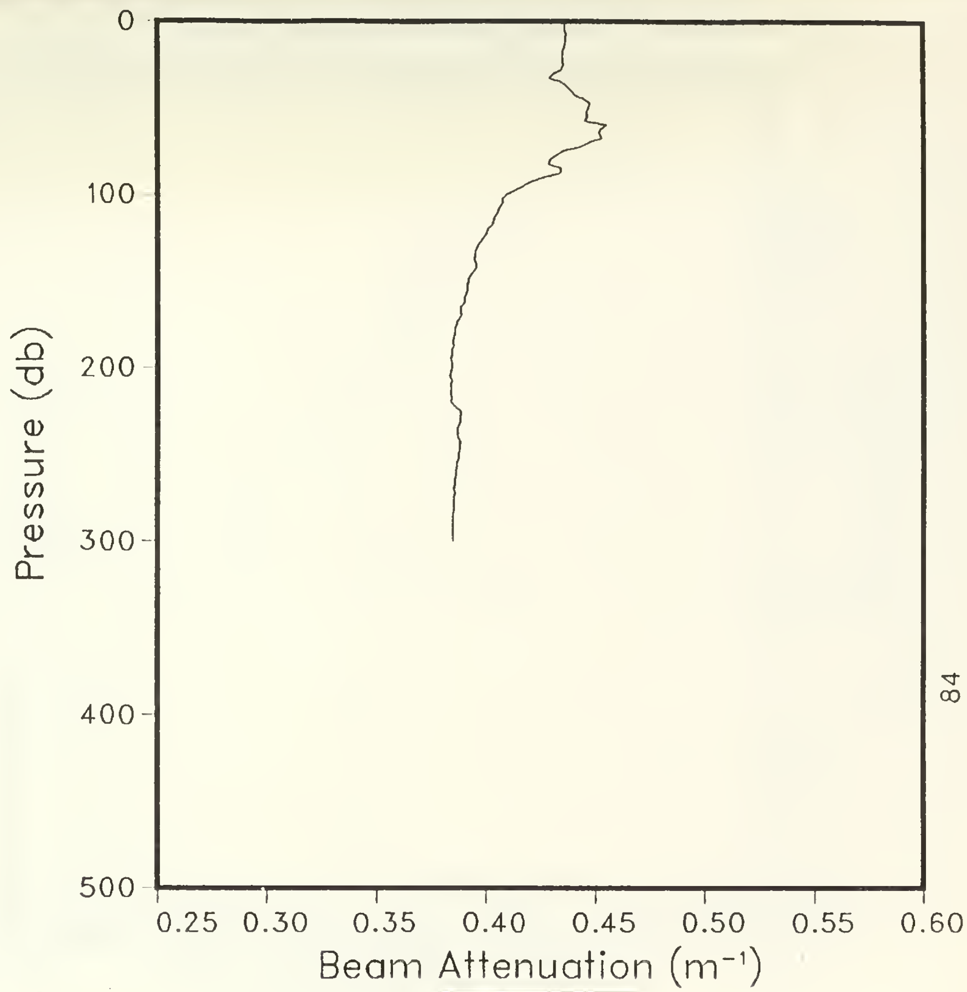


Latitude: 34.464°
Longitude: 126.983°

Date: 10/19/82
Time: 846:20 GMT

R/V ACANIA CRUISE ODEX3 STATION 41

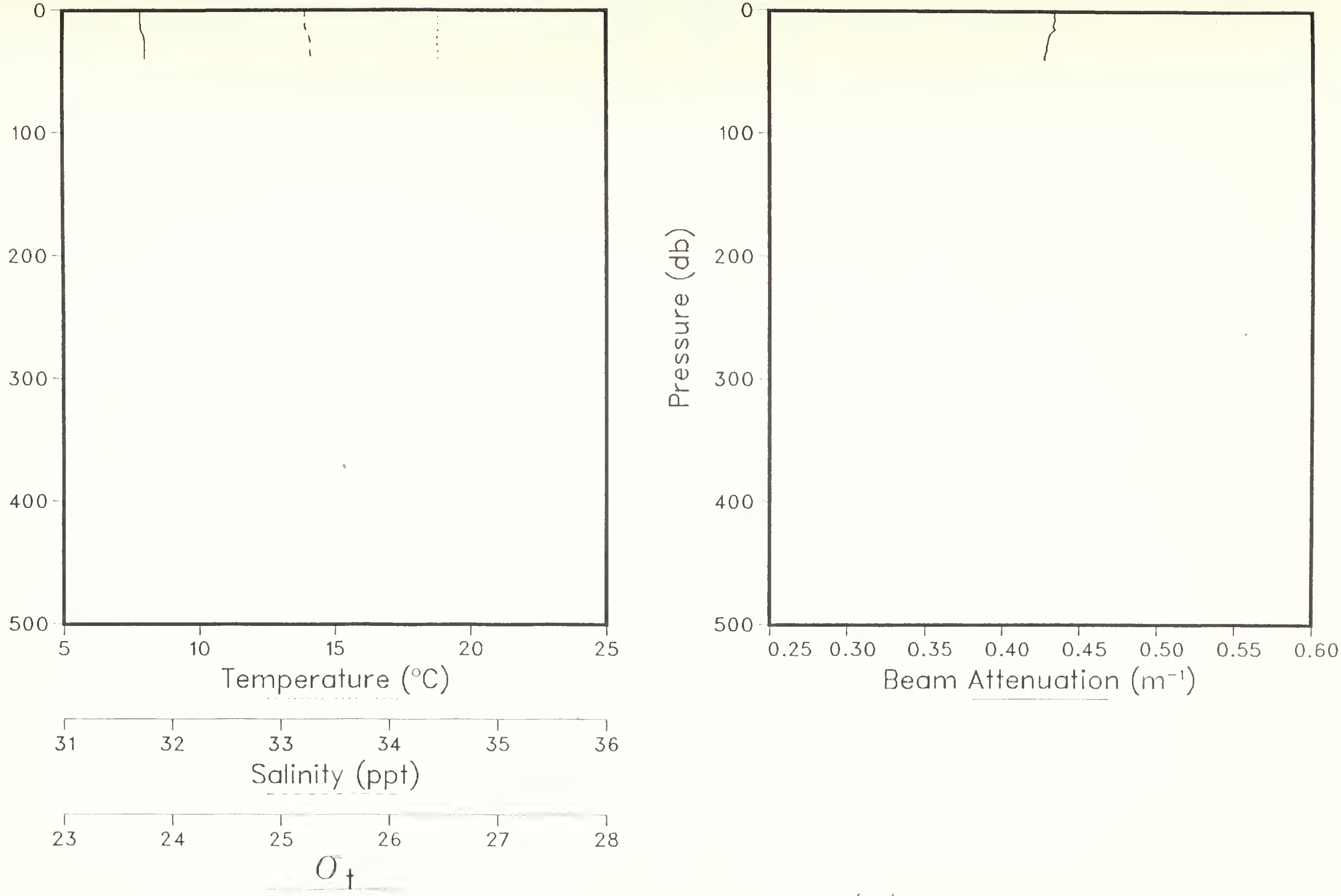




Latitude: 34.492°
Longitude: 127.378°

Date: 10/19/82
Time: 1242:14 GMT

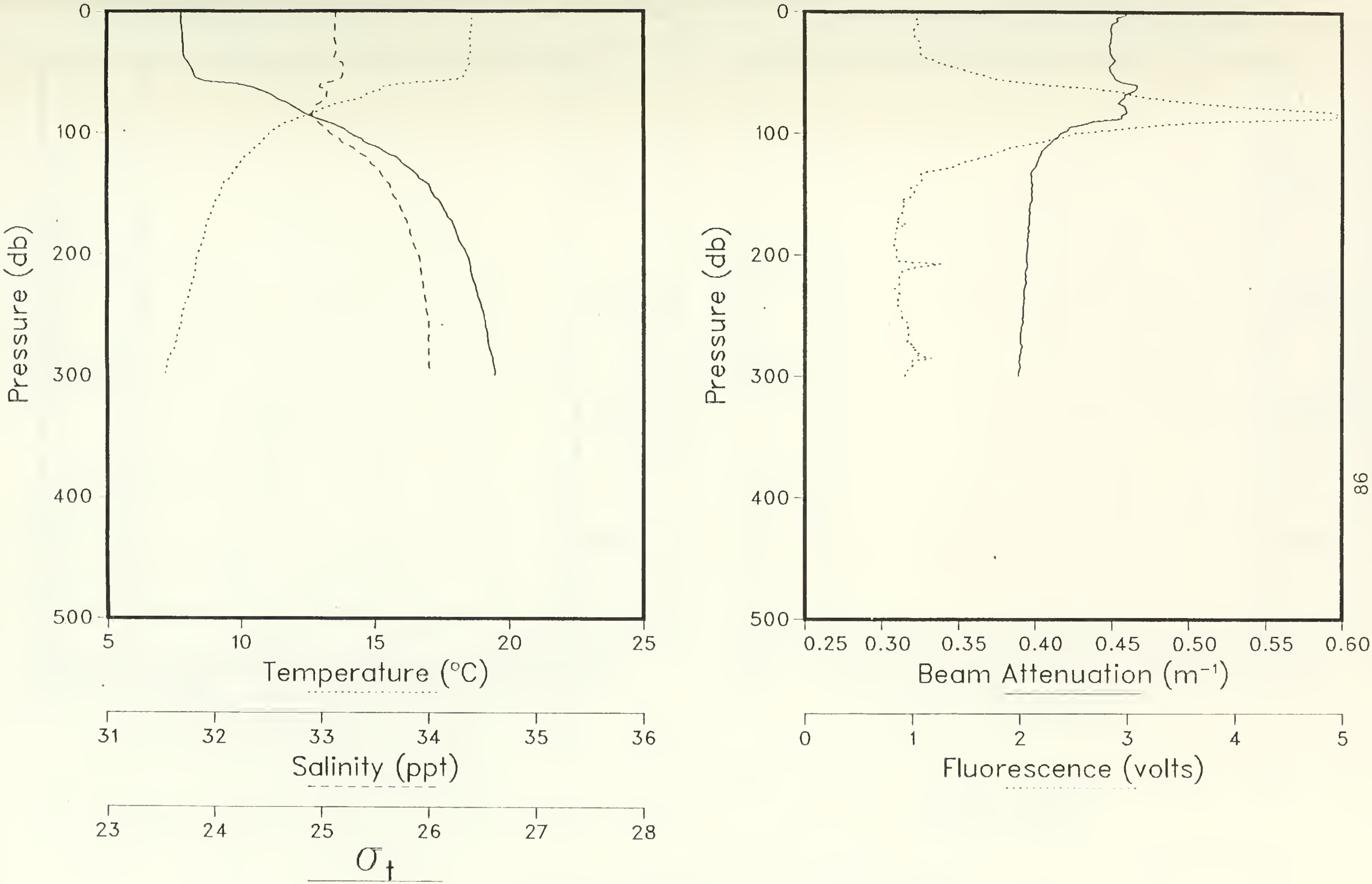
R/V ACANIA CRUISE ODEX3 STATION 42



Latitude: 34.503°
Longitude: 127.682°

Date: 10/19/82
Time: 1608:50 GMT

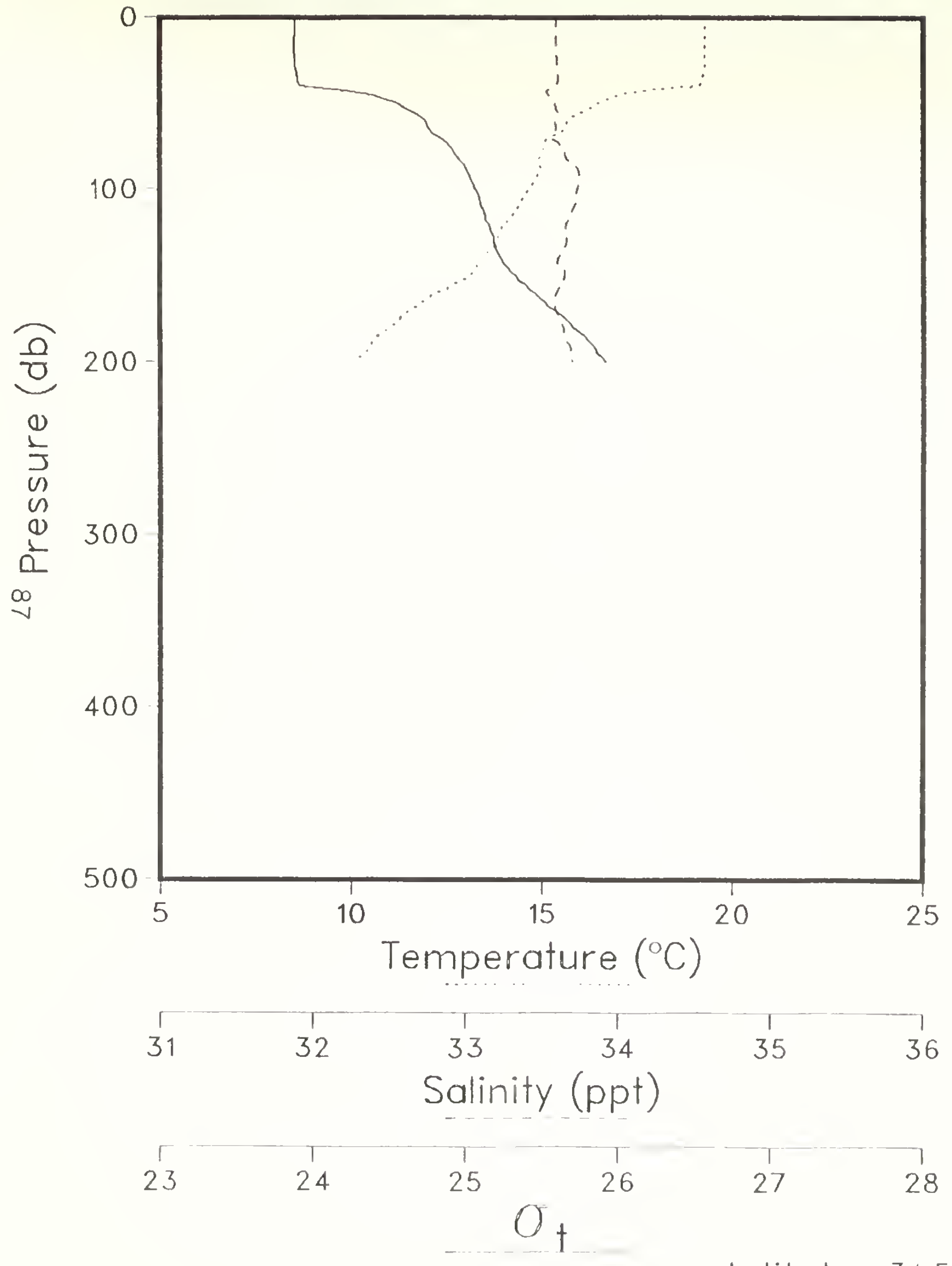
R/V ACANIA CRUISE ODEX3 STATION 43

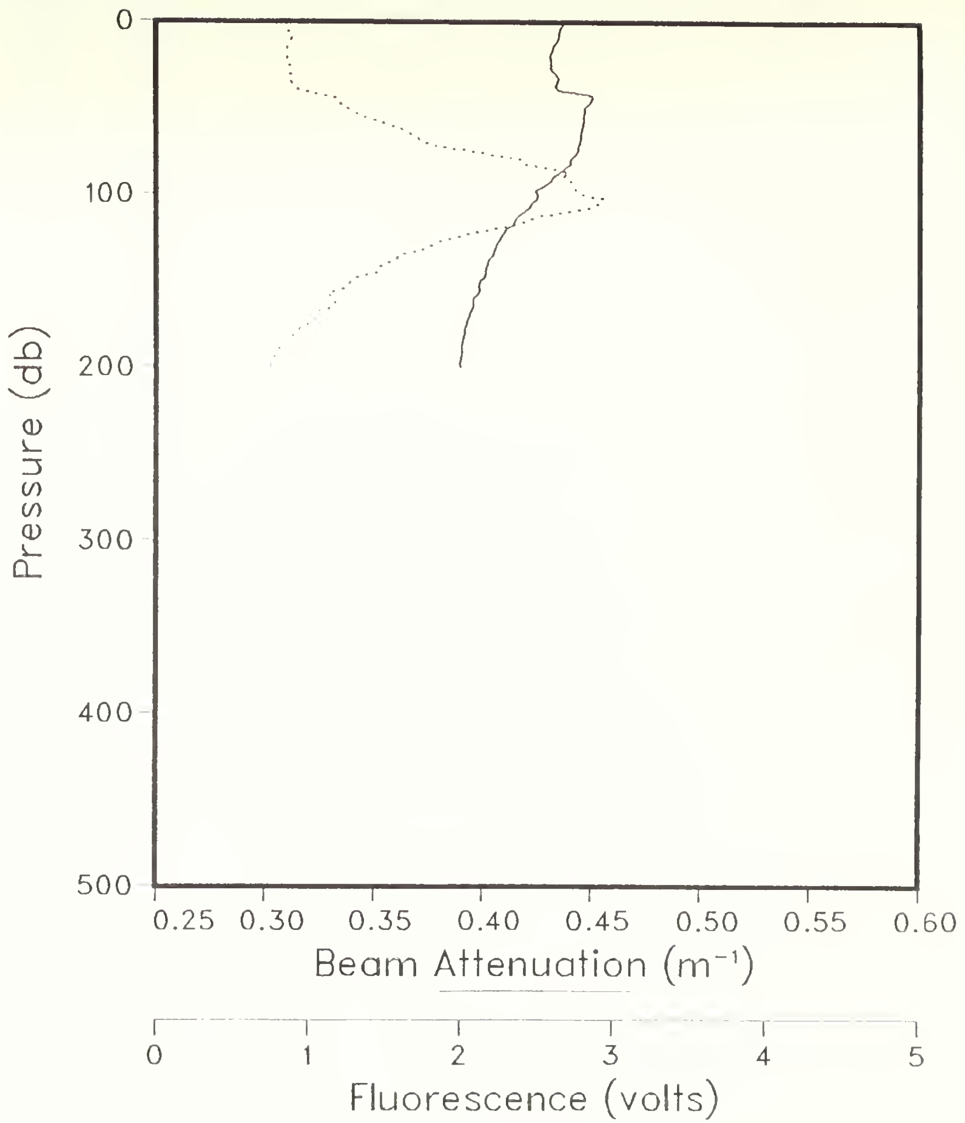


Latitude: 34.496°
Longitude: 128.783°

Date: 10/20/82
Time: 148:32 GMT

R/V ACANIA CRUISE ODEX3 STATION 45

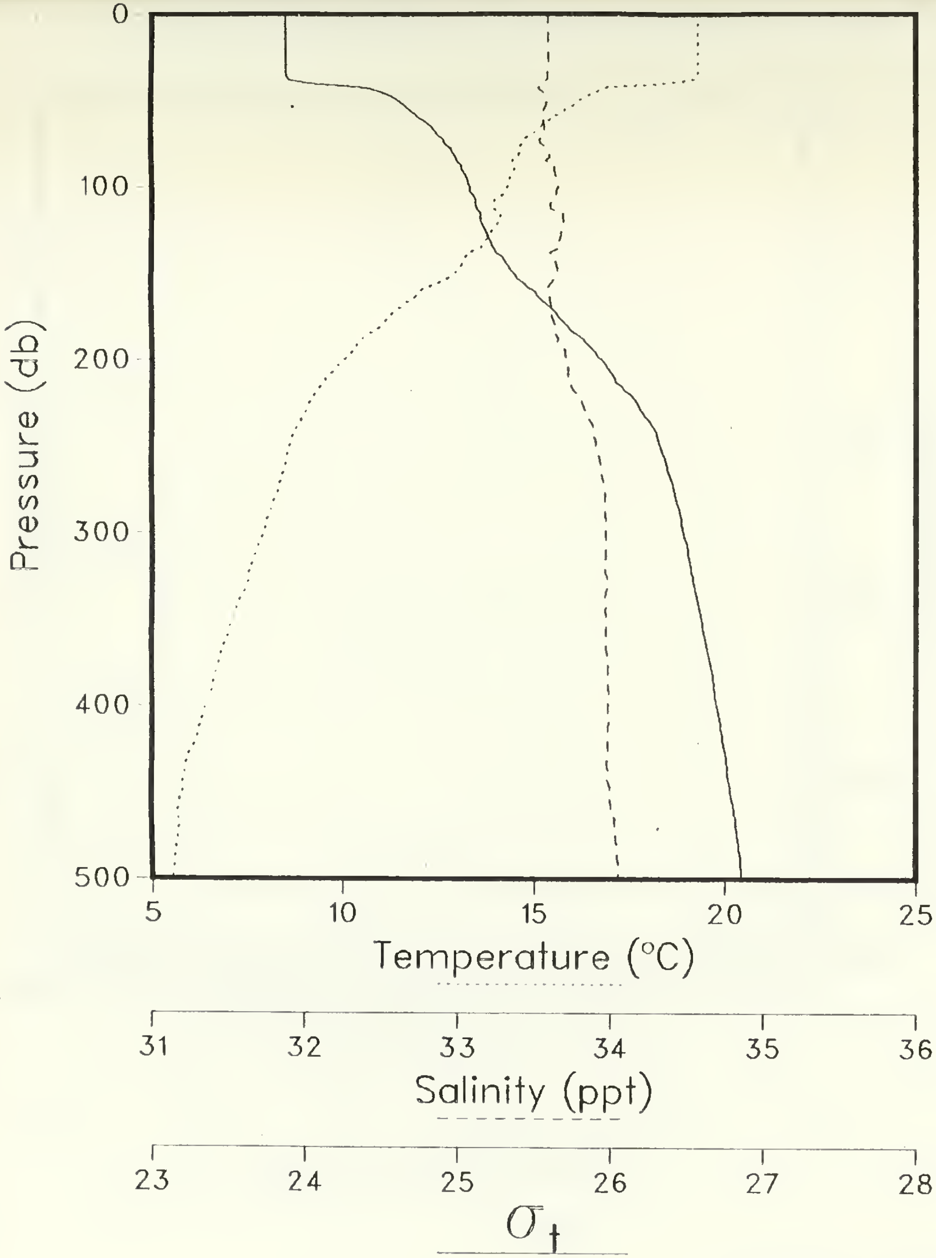


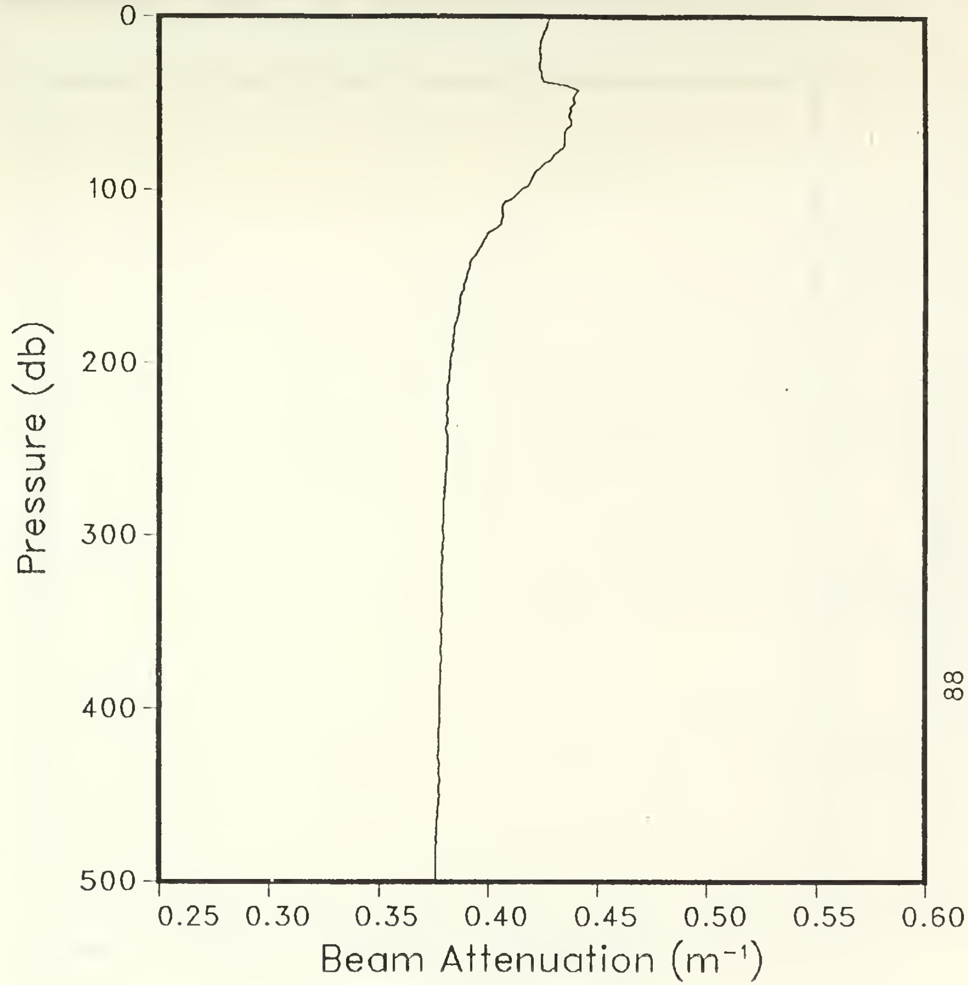


Latitude: 34.511°
Longitude: 130.795°

Date: 10/20/82
Time: 1700:38 GMT

R/V ACANIA CRUISE ODEX3 STATION 46

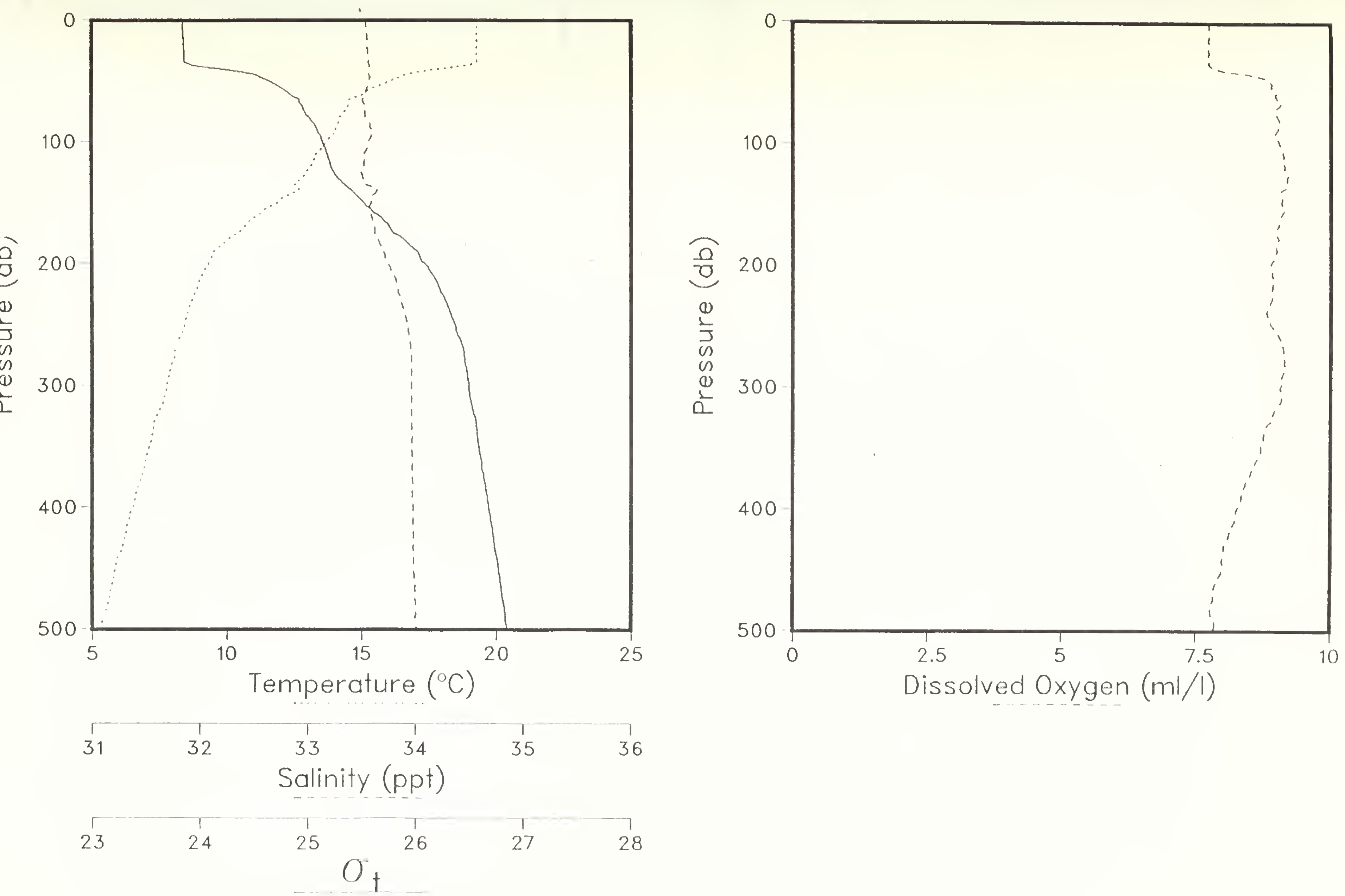




Latitude: 34.526°
Longitude: 130.781°

Date: 10/20/82
Time: 1721:01 GMT

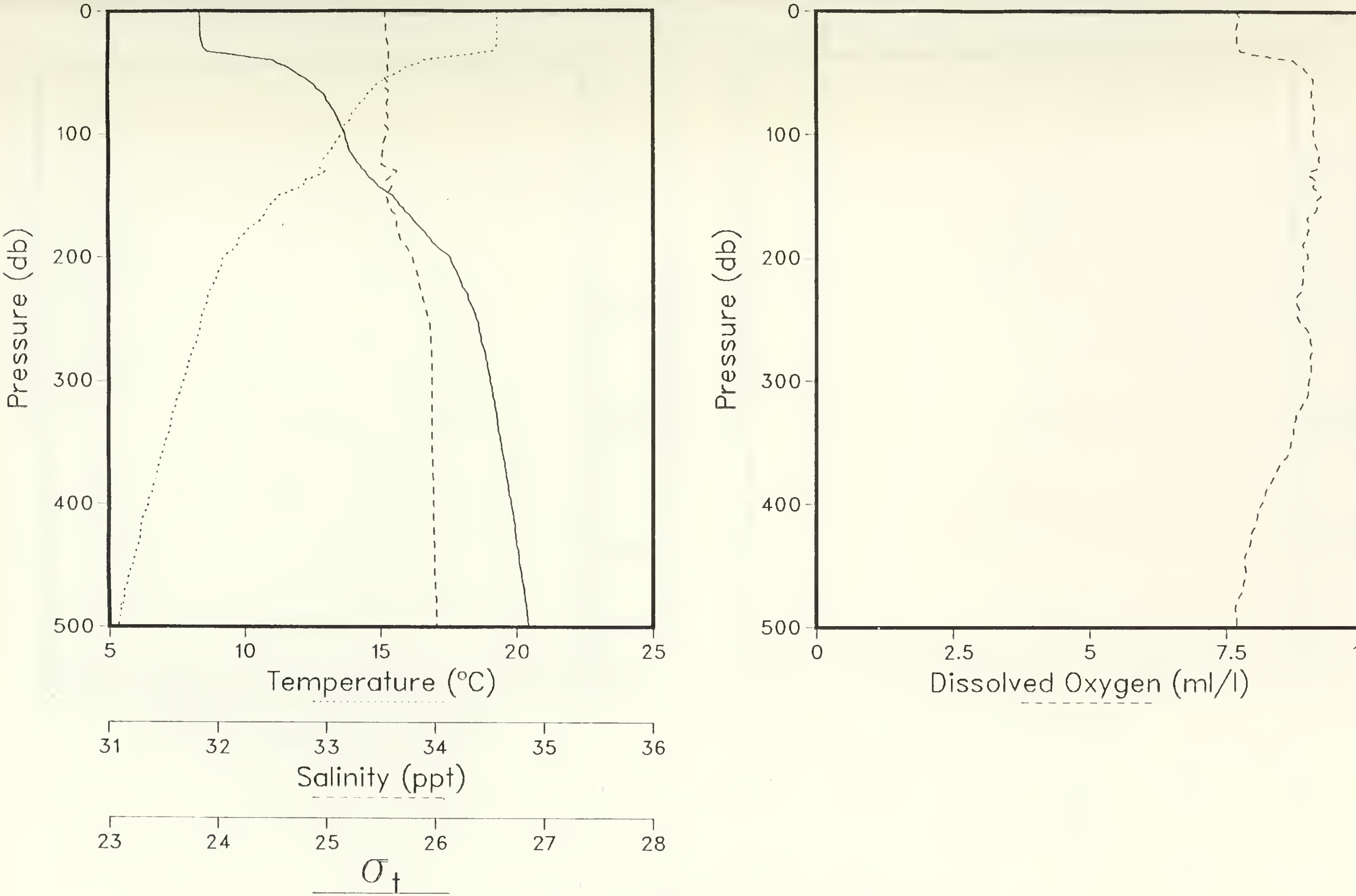
R/V ACANIA CRUISE ODEX3 STATION 46B



Latitude: 34.526°
Longitude: 130.781°

Date: 10/20/82
Time: 2203:37 GMT

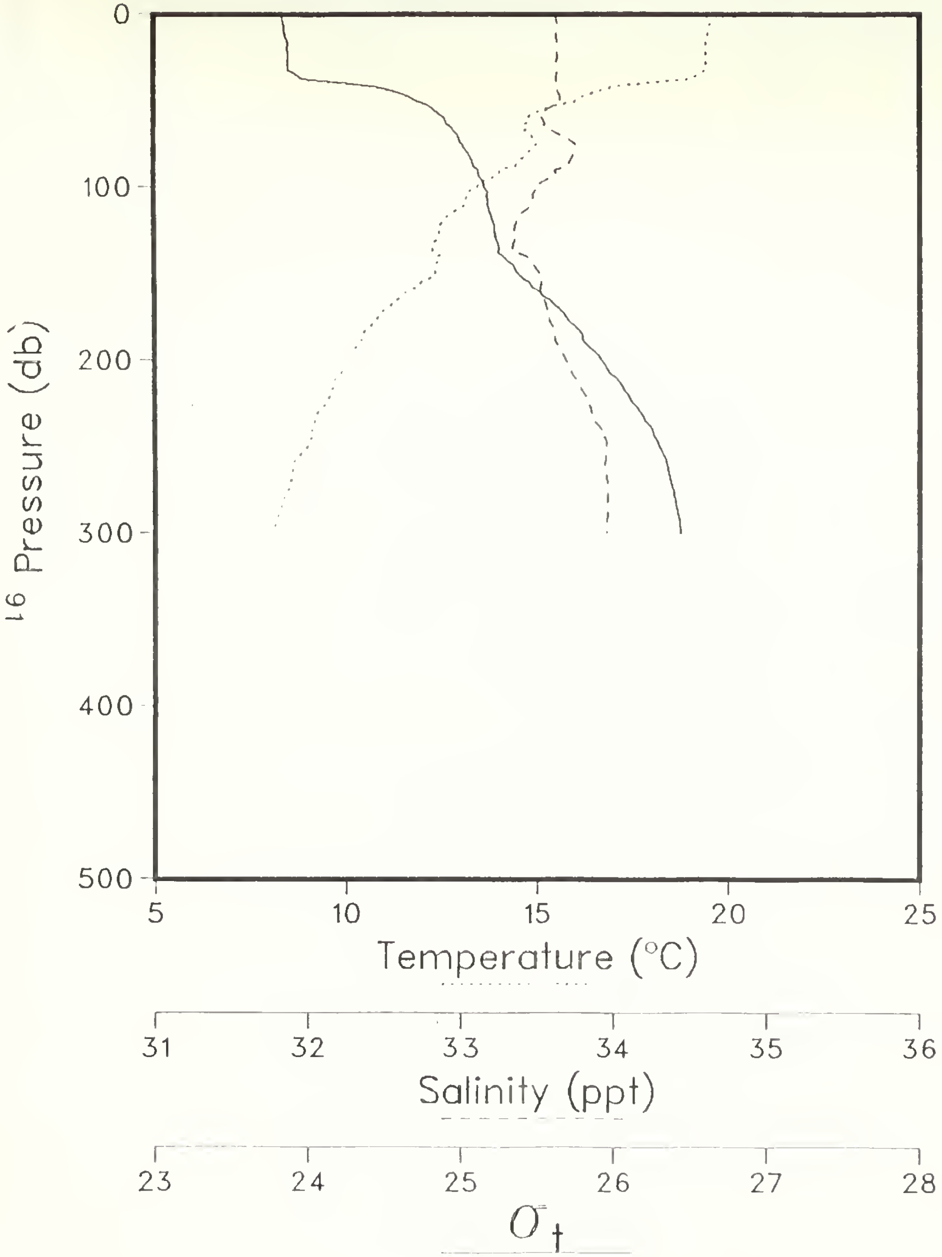
R/V ACANIA CRUISE ODEX3 STATION 46C

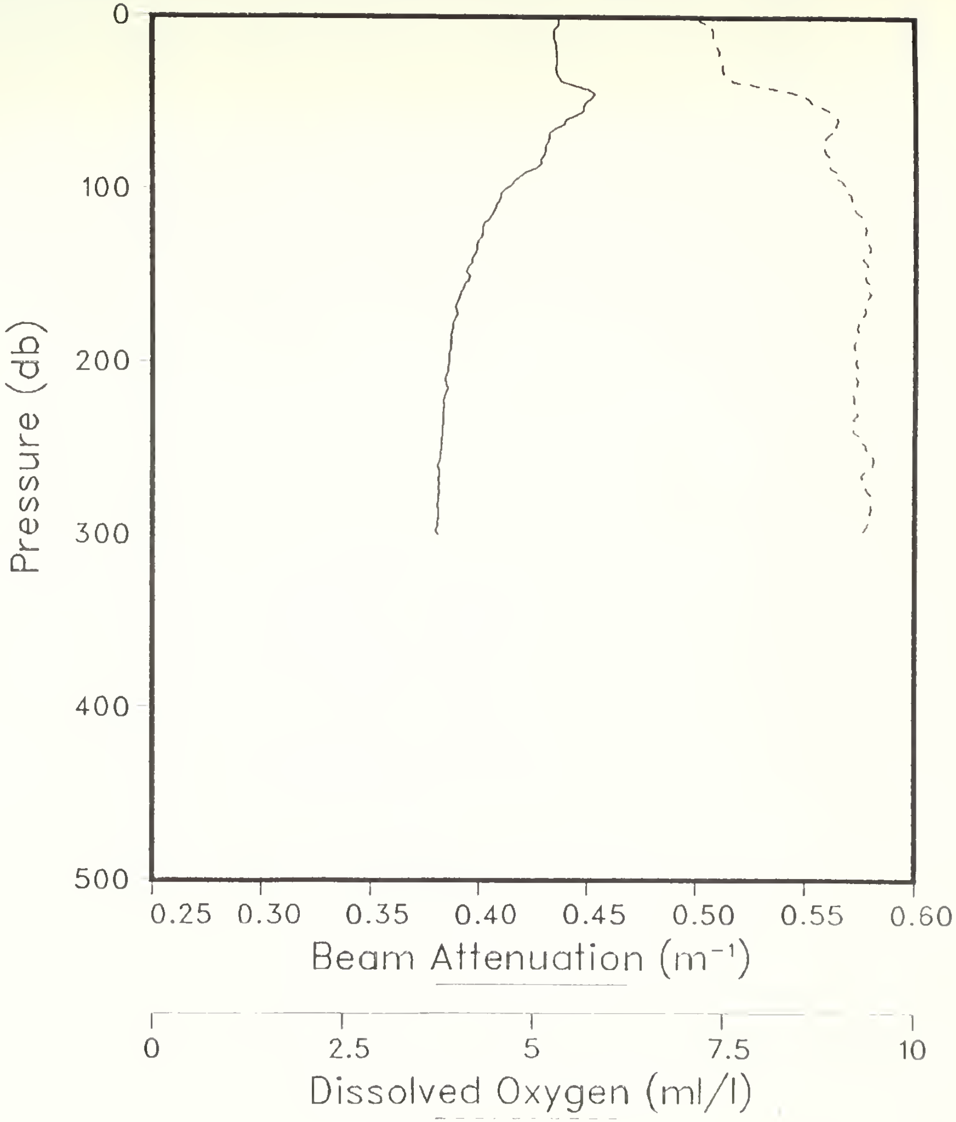


Latitude: 34.526°
Longitude: 130.781°

Date: 10/20/82
Time: 2352:15 GMT

R/V ACANIA CRUISE ODEX3 STATION 46D

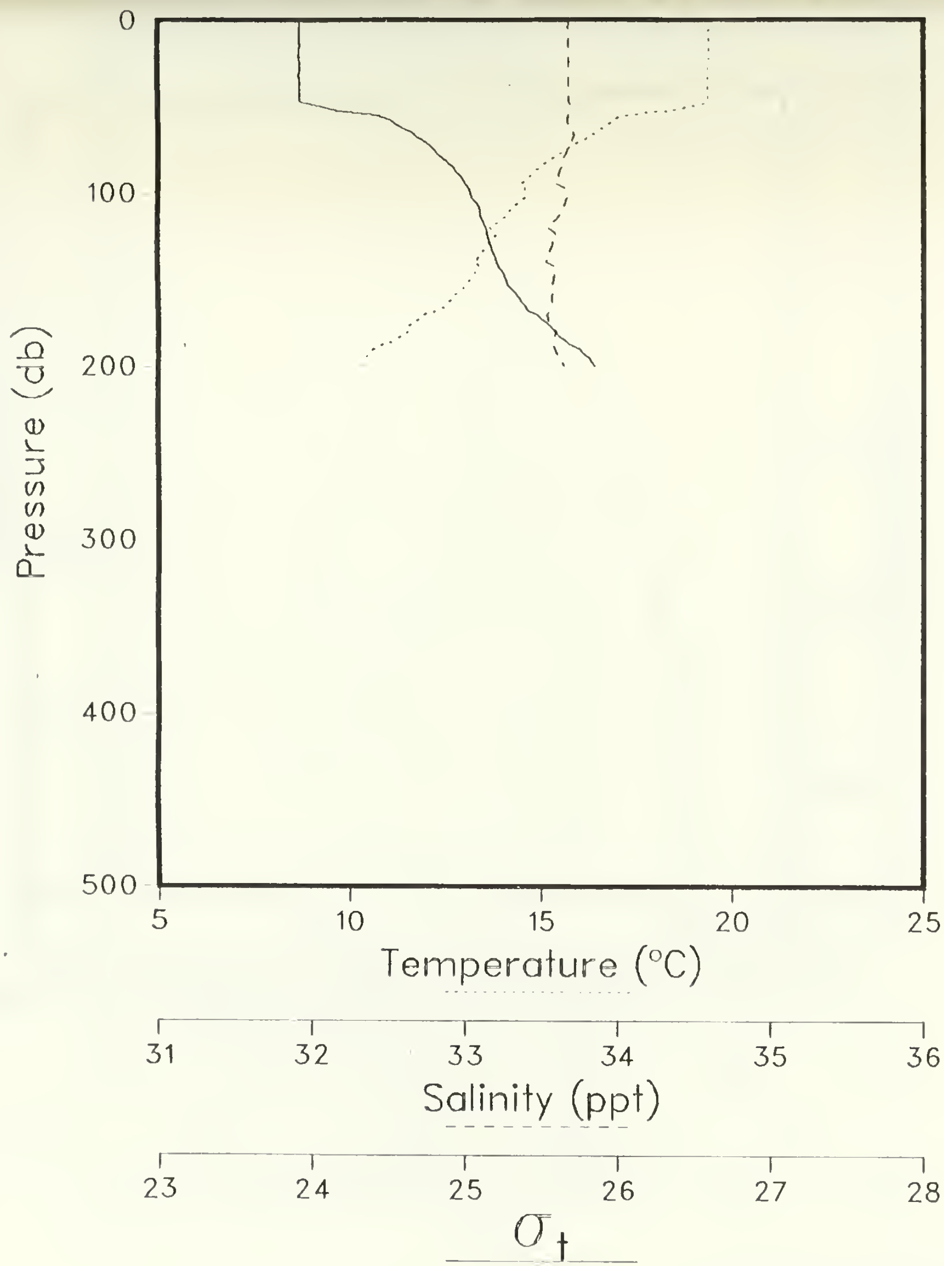


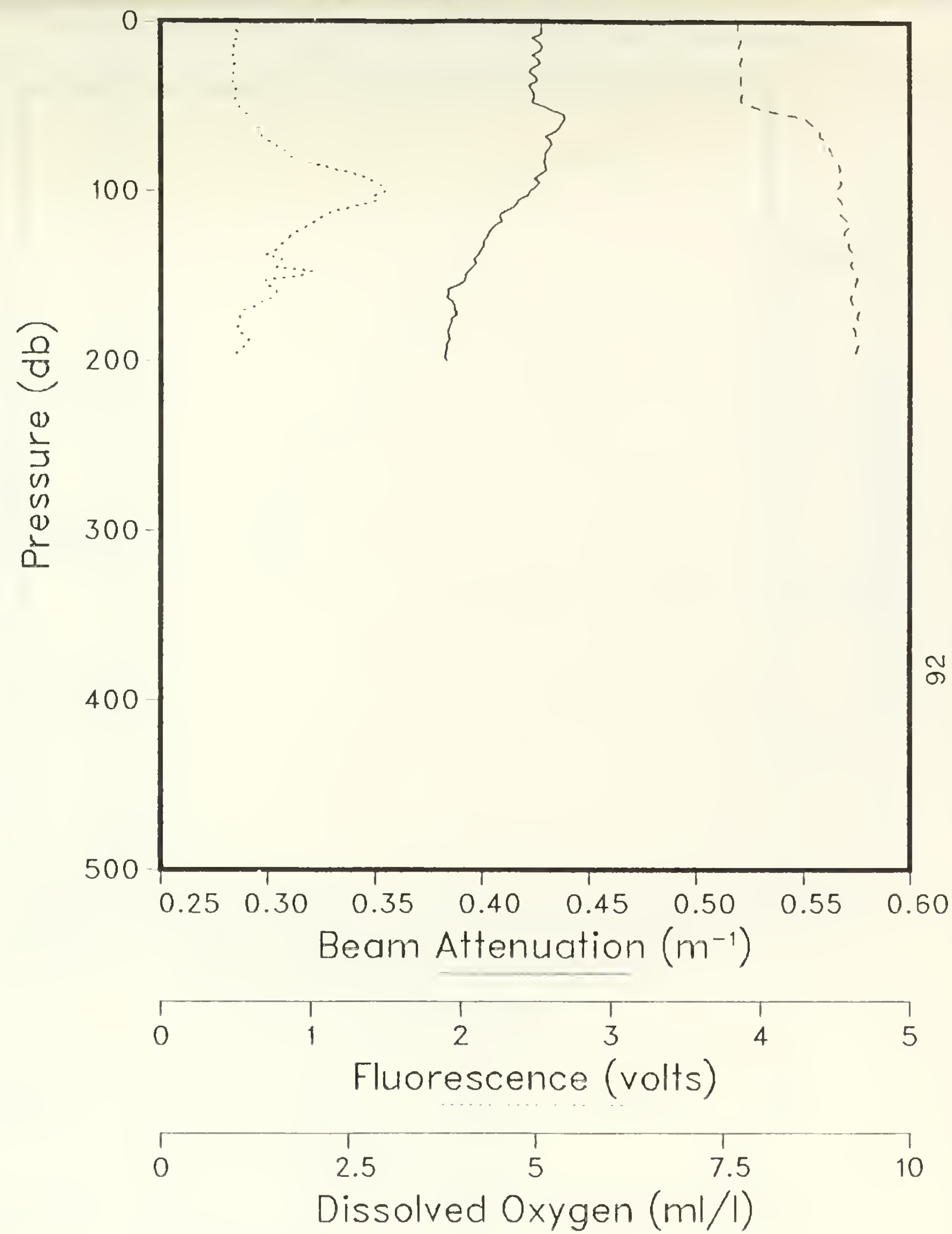


Latitude: 34.205°
Longitude: 134.373°

Date: 10/22/82
Time: 2227:05 GMT

R/V ACANIA CRUISE ODEX3 STATION 47

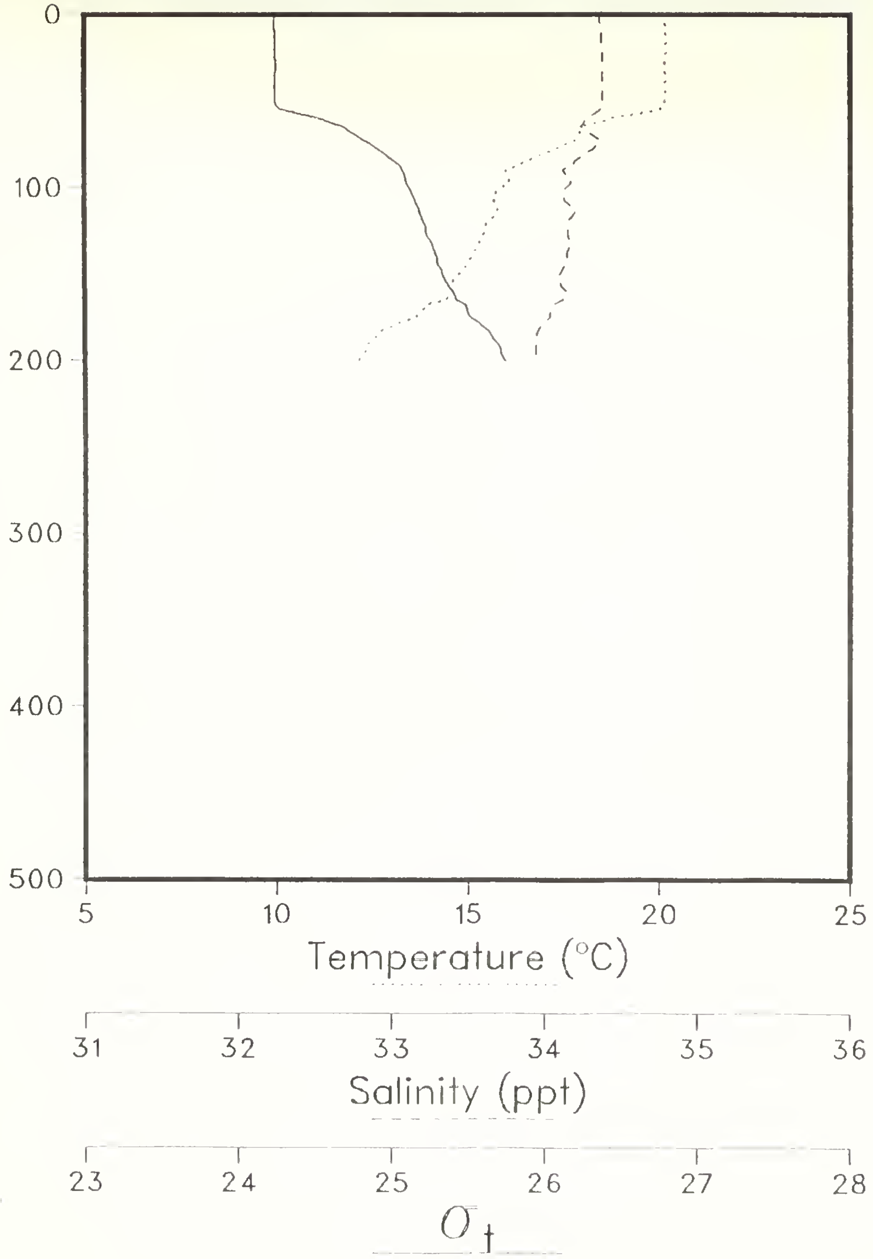


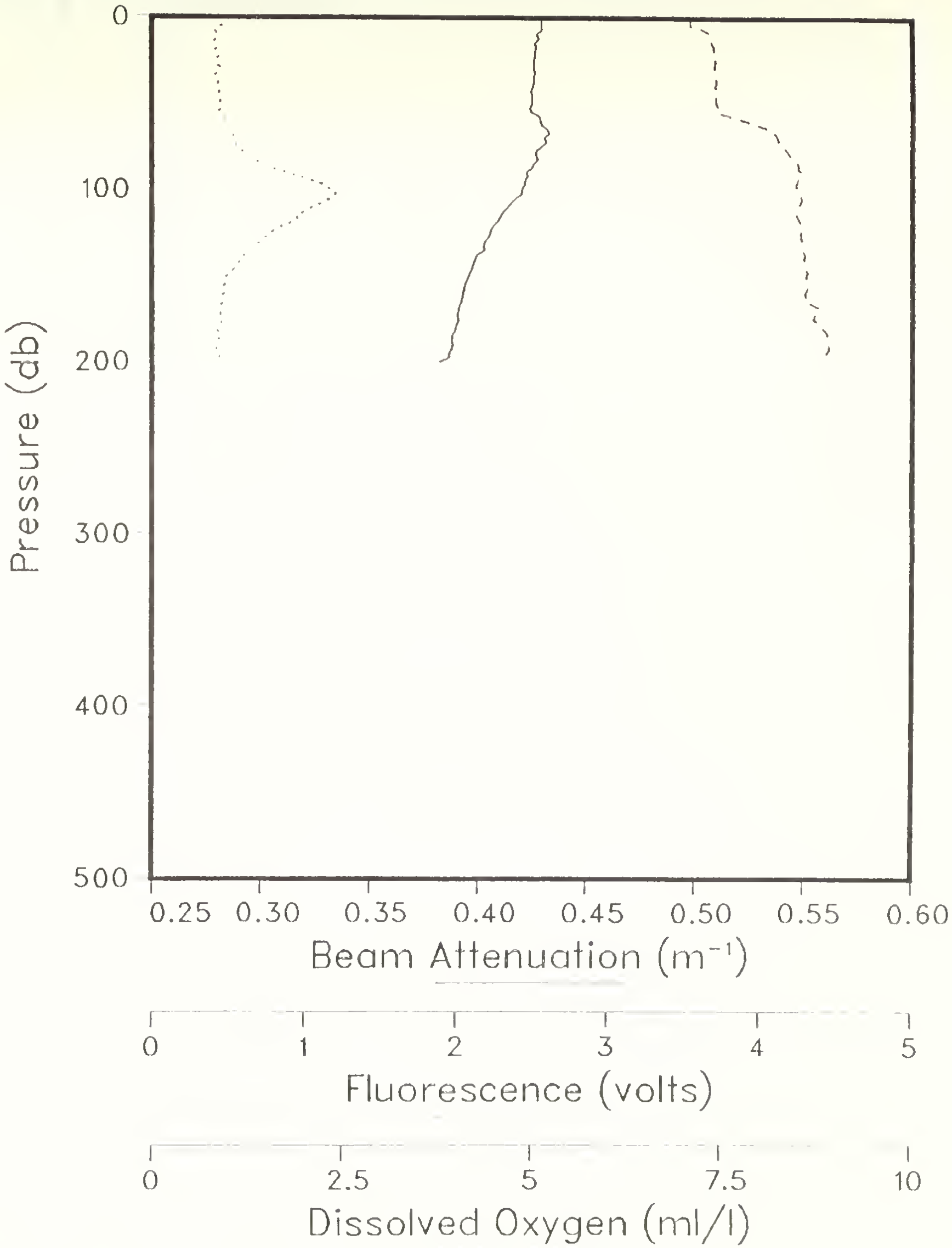


Latitude: 34.189°
Longitude: 135.533°

Date: 10/23/82
Time: 707:51 GMT

R/V ACANIA CRUISE ODEX3 STATION 48

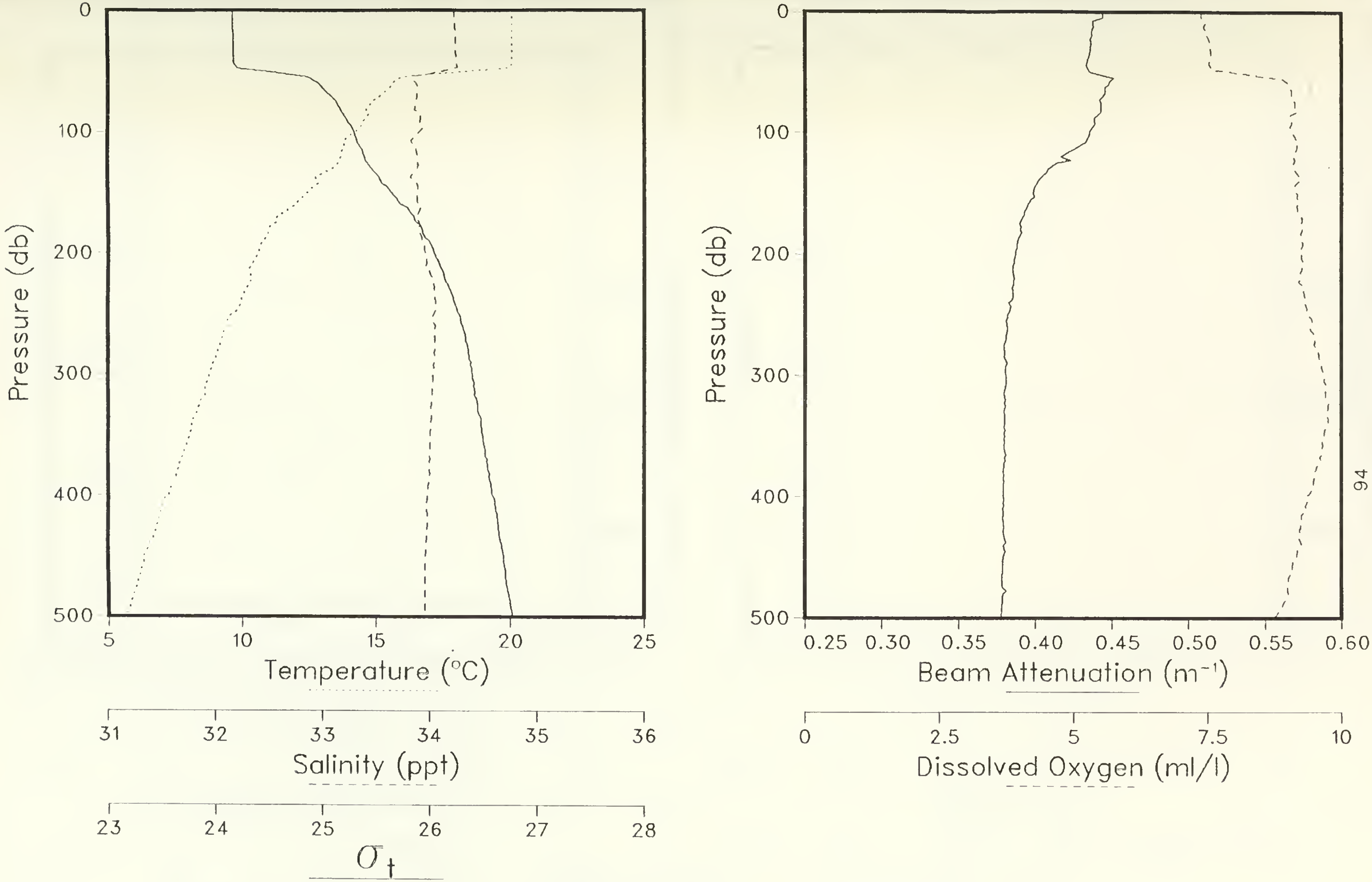




Latitude: 34.228°
Longitude: 136.630°

Date: 10/23/82
Time: 1819:54 GMT

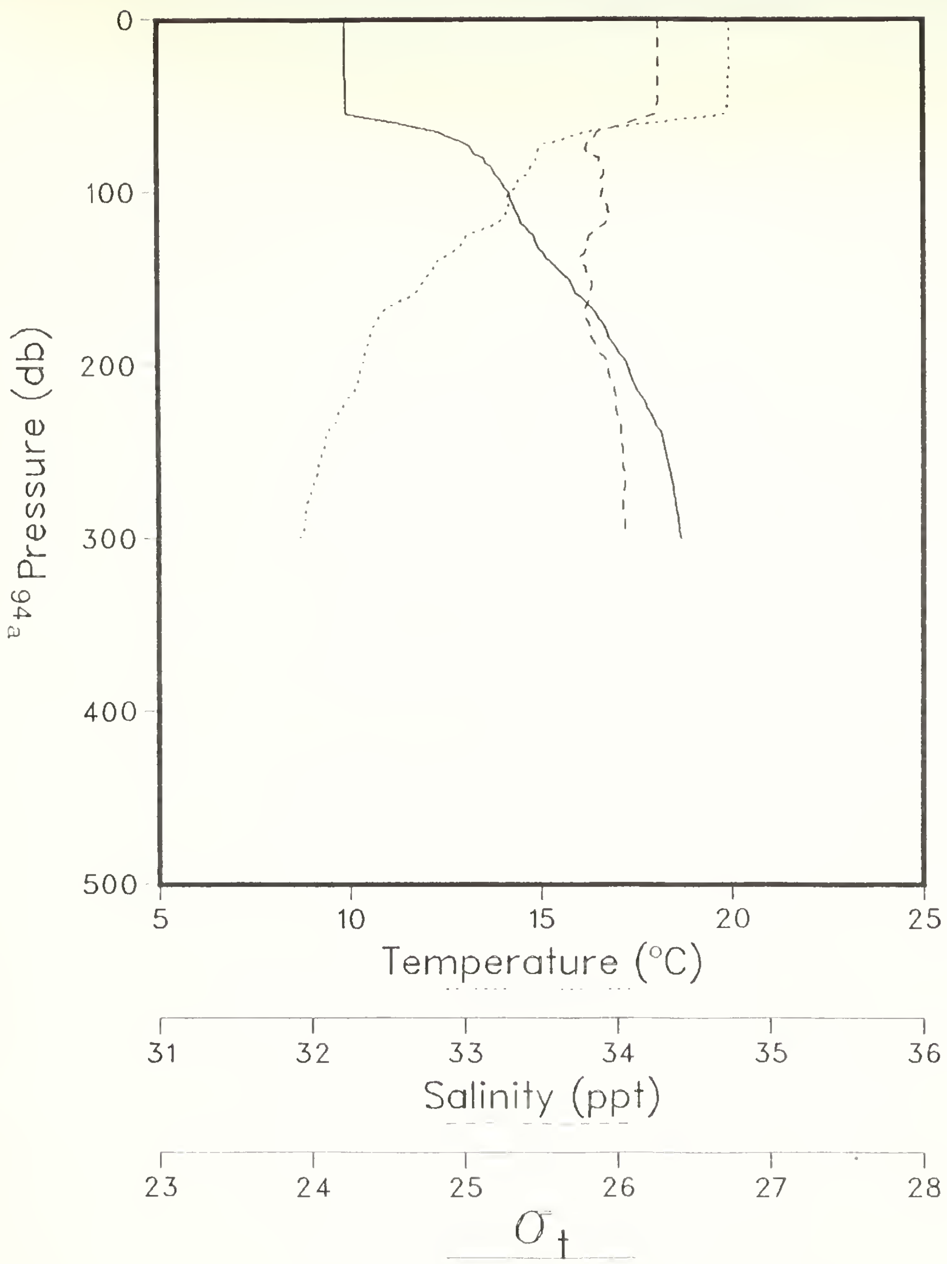
R/V ACANIA CRUISE ODEX3 STATION 49

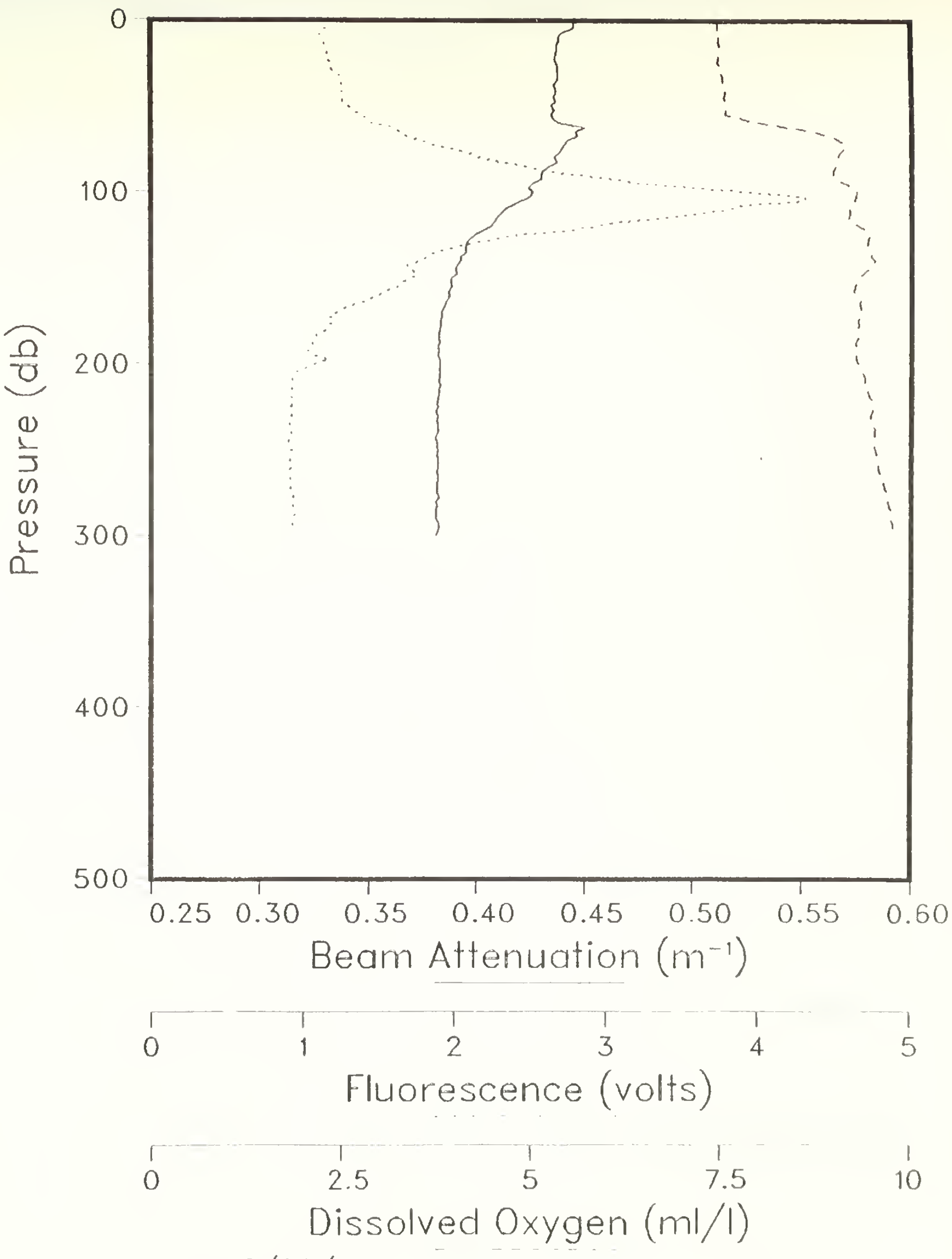


Latitude: 33.978°
Longitude: 140.855°

Date: 10/25/82
Time: 1857:16 GMT

R/V ACANIA CRUISE ODEX3 STATION 50

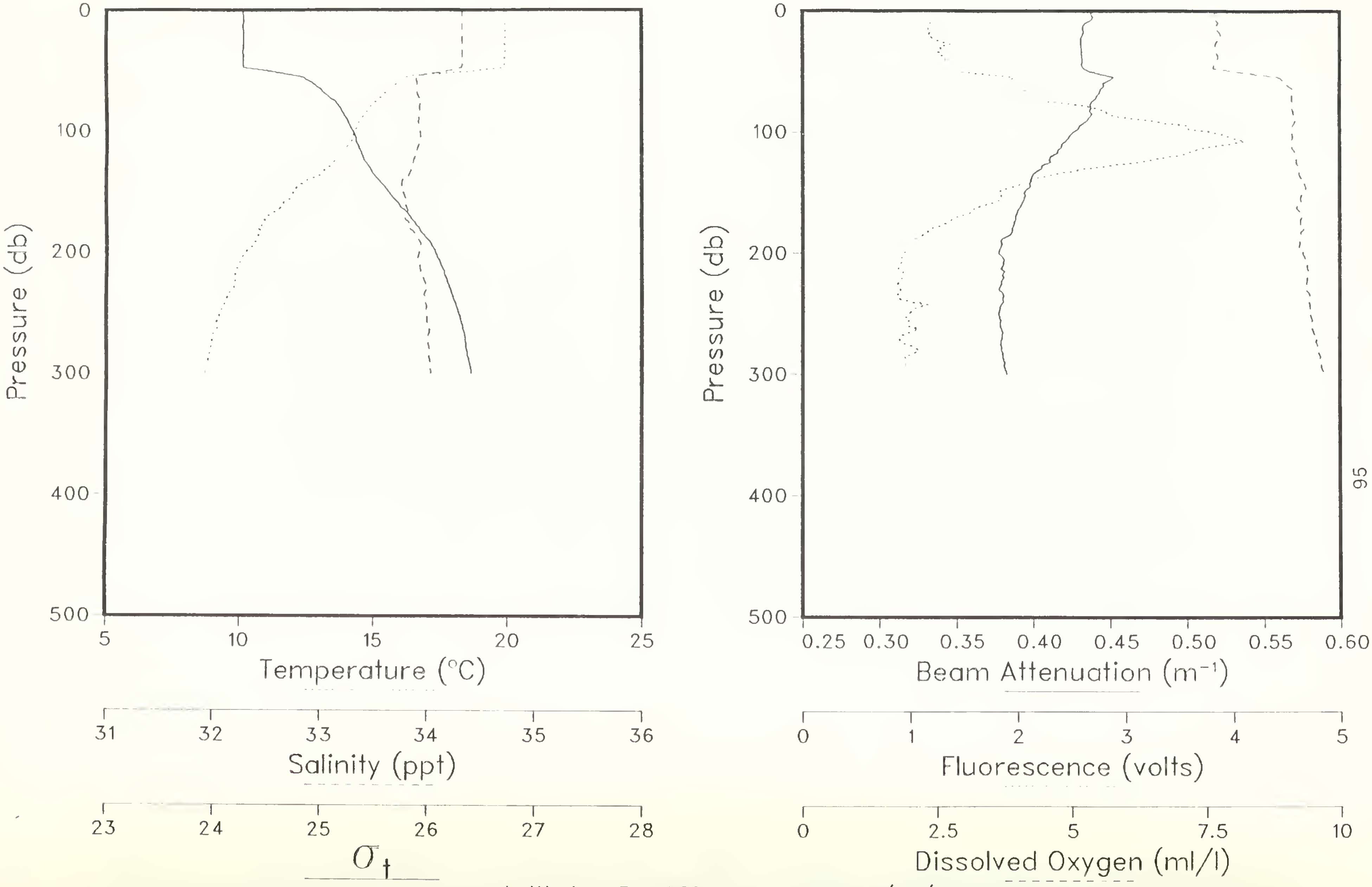




Latitude: 34.021°
Longitude: 141.150°

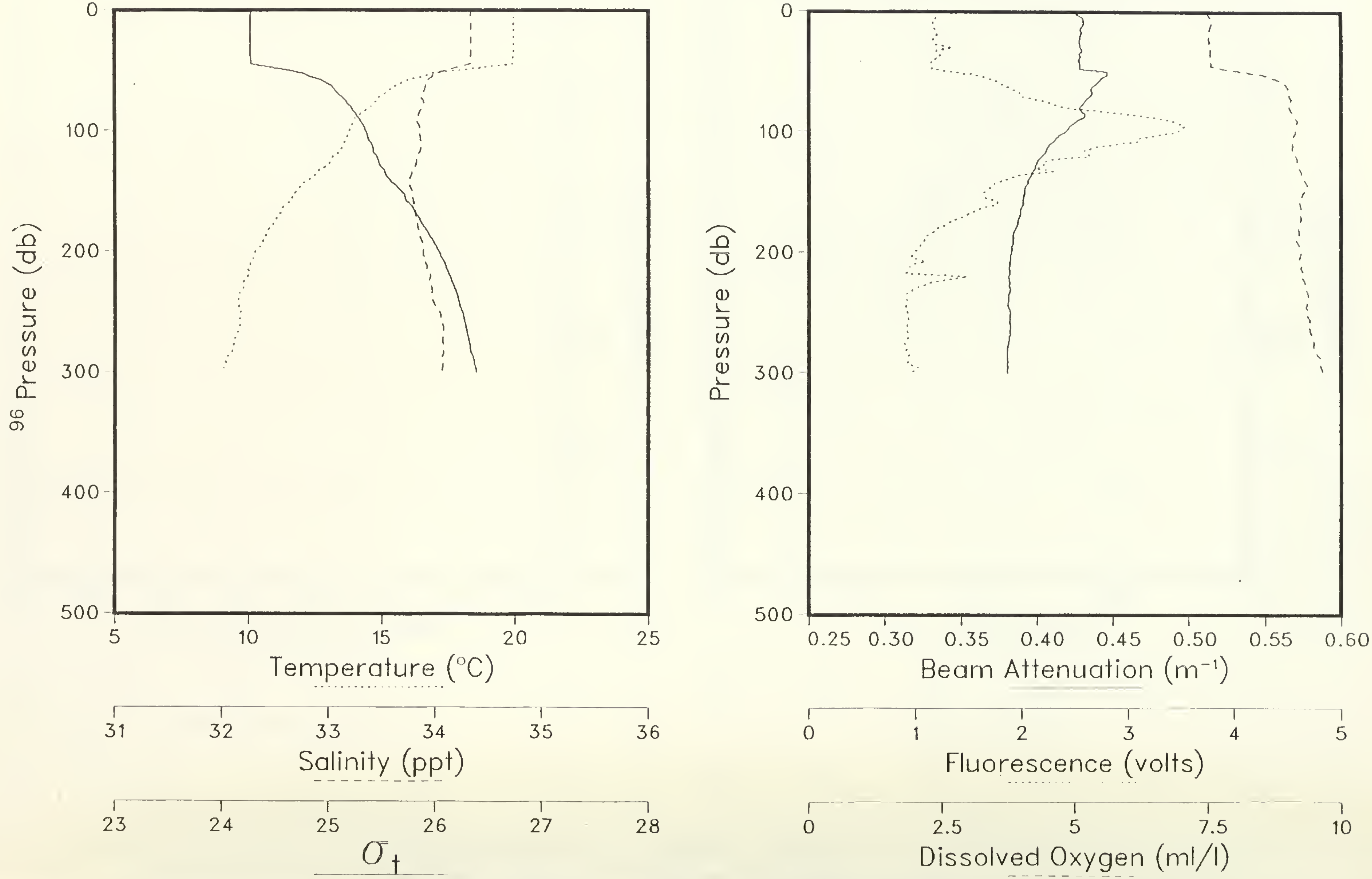
Date: 10/26/82
Time: 104:19 GMT

R/V ACANIA CRUISE ODEX3 STATION 51



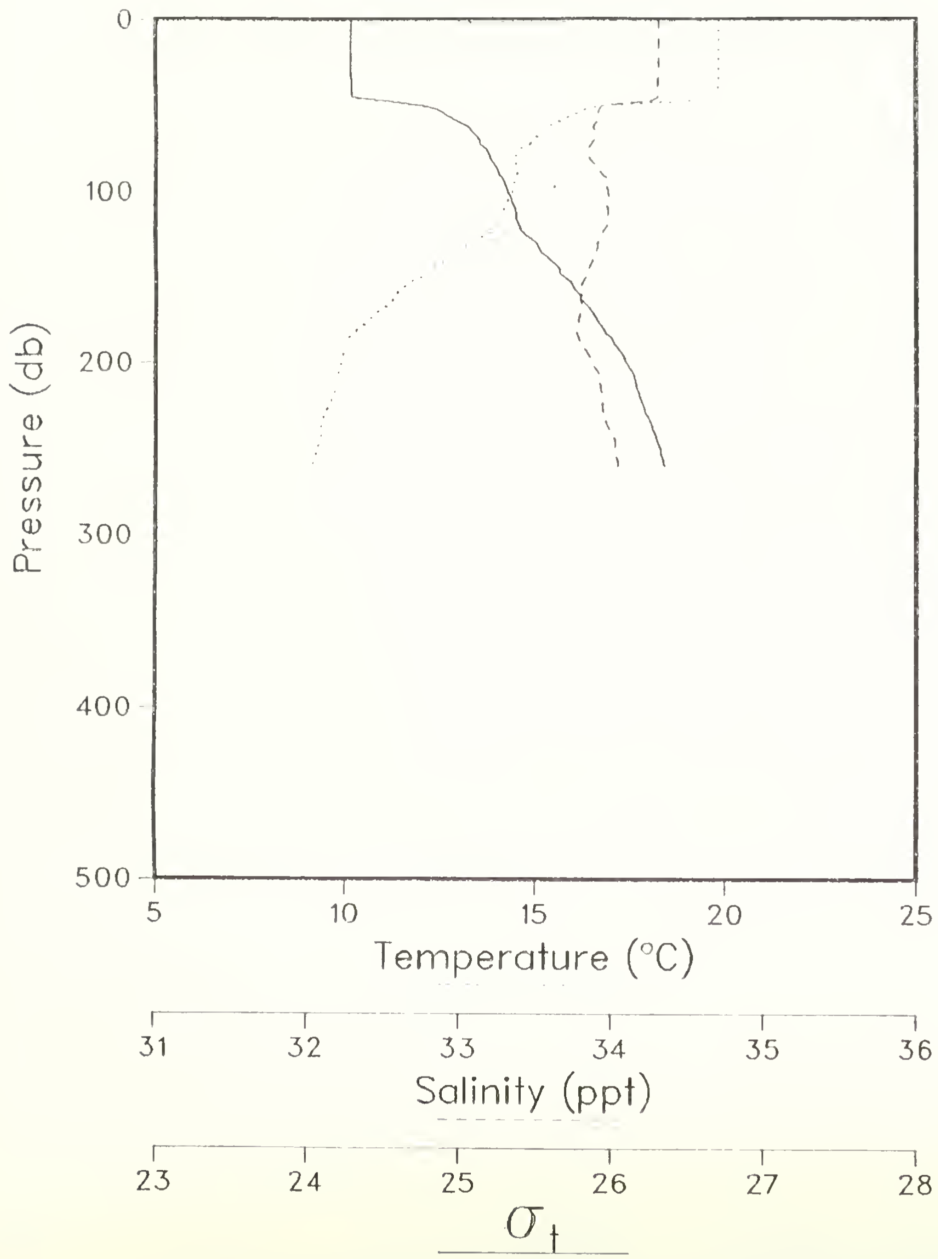
Latitude: 34.008°
Longitude: 141.508°

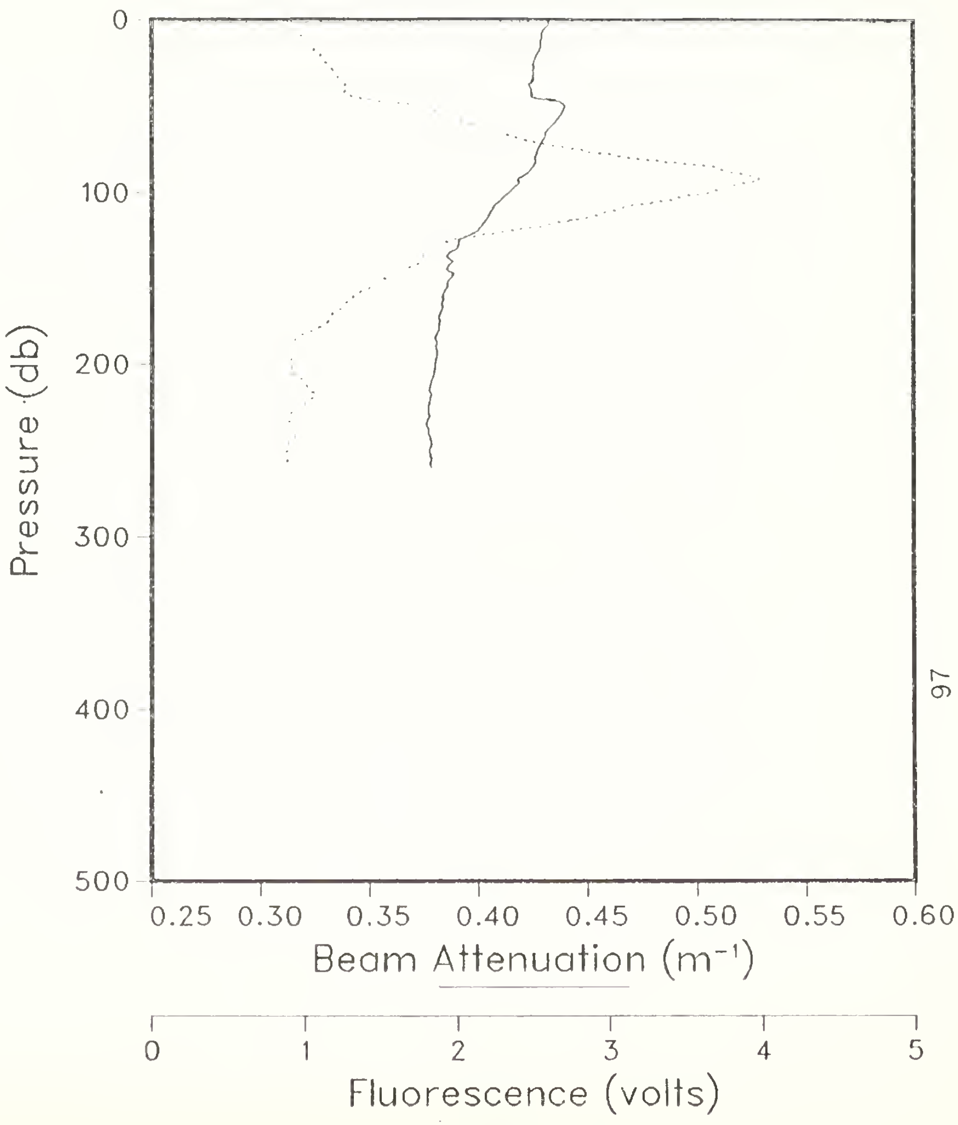
Date: 10/26/82
Time: 449:06 GMT



Latitude: 33.572°
Longitude: 141.865°

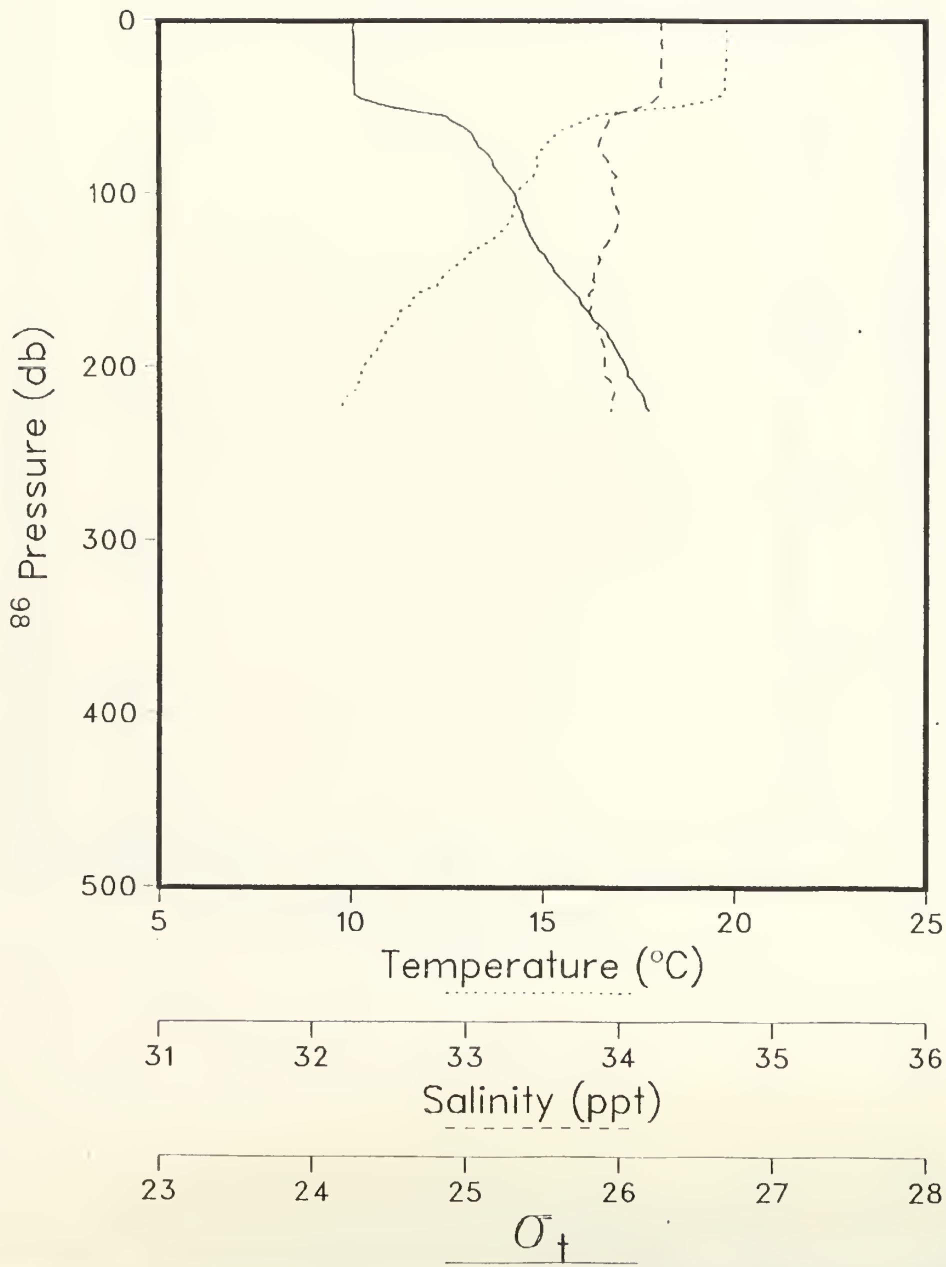
Date: 10/26/82
Time: 1540:35 GMT

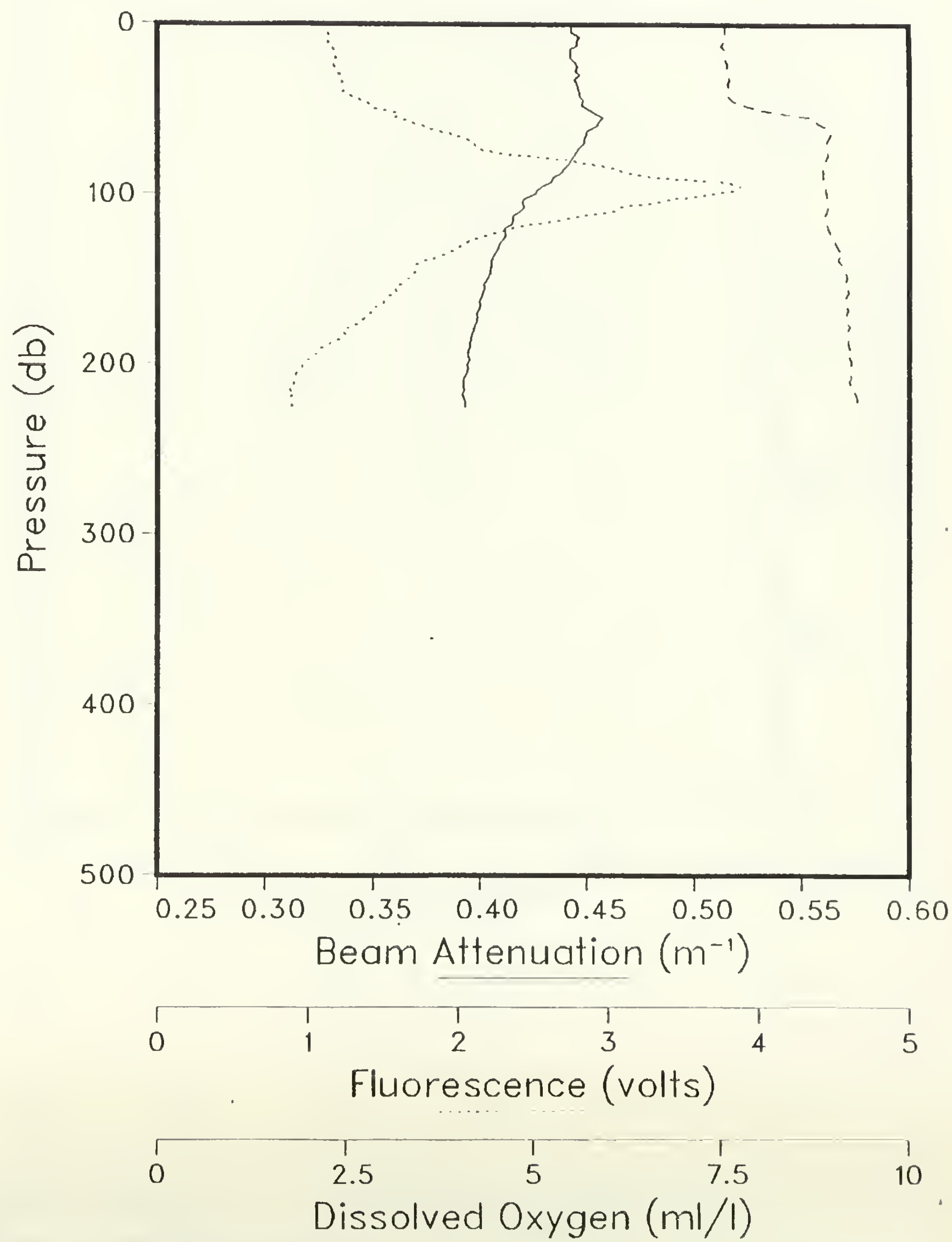




Latitude: 33.669°
Longitude: 141.868°

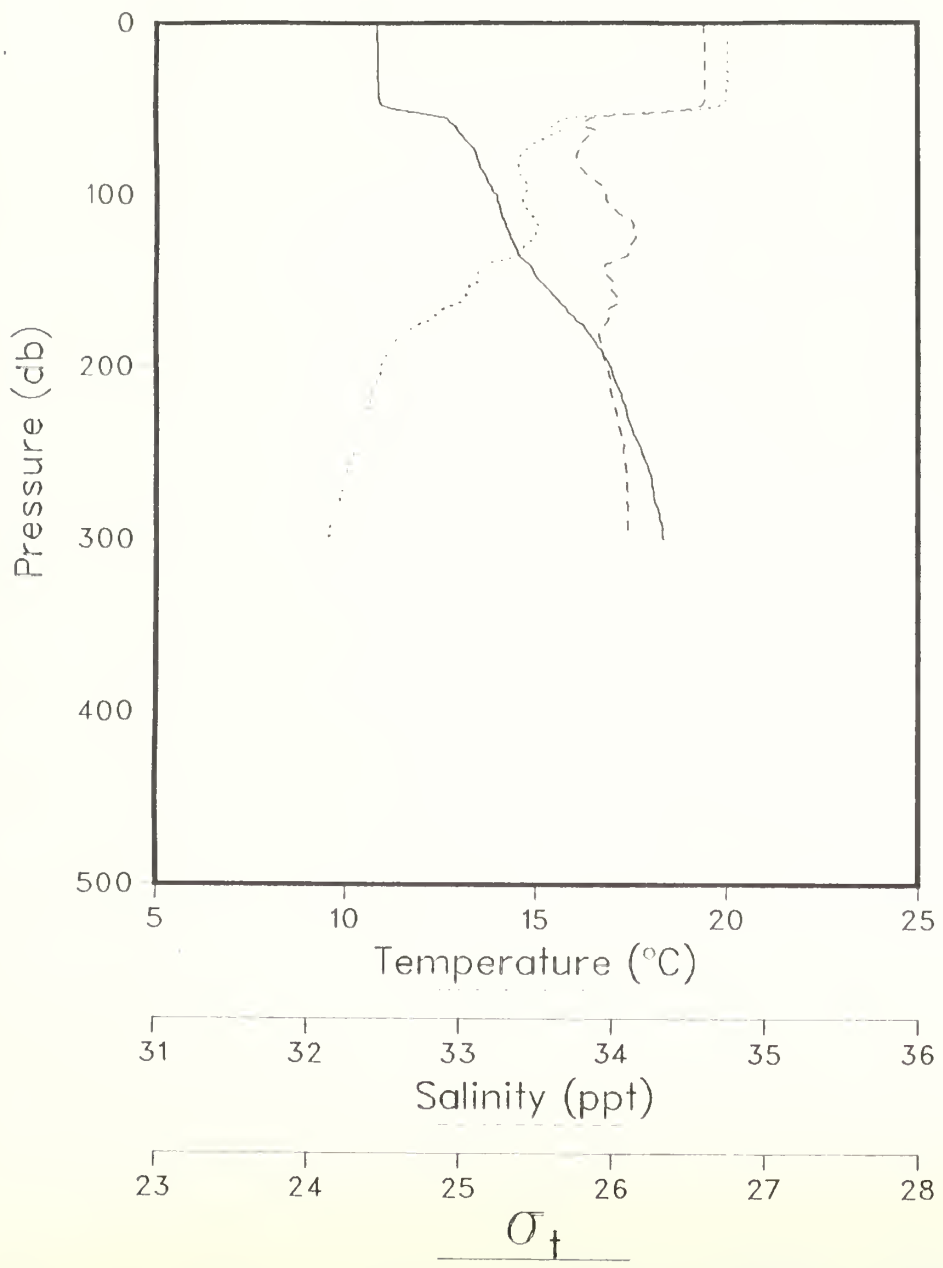
Date: 10/26/82
Time: 1919:57 GMT

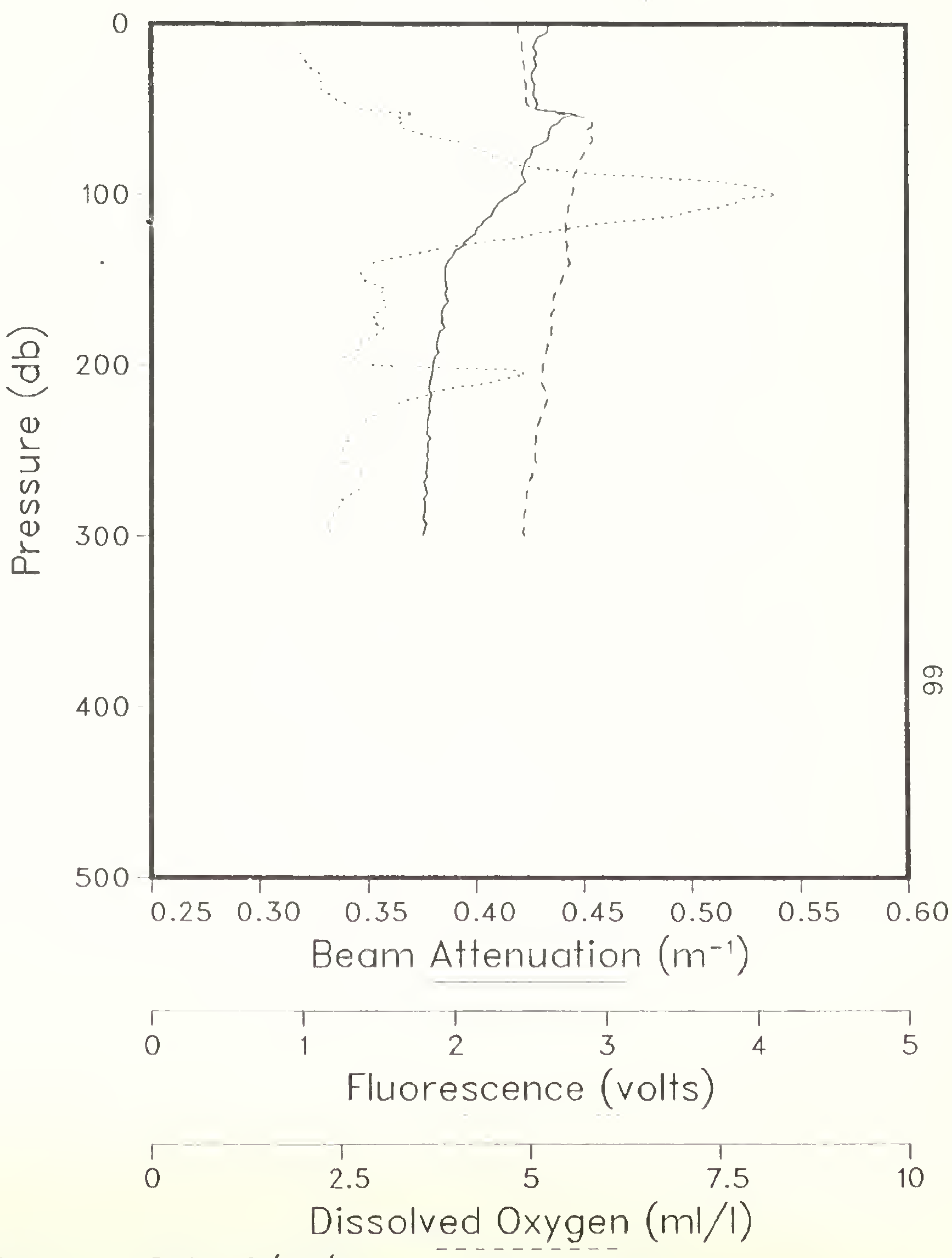




Latitude: 33.867°

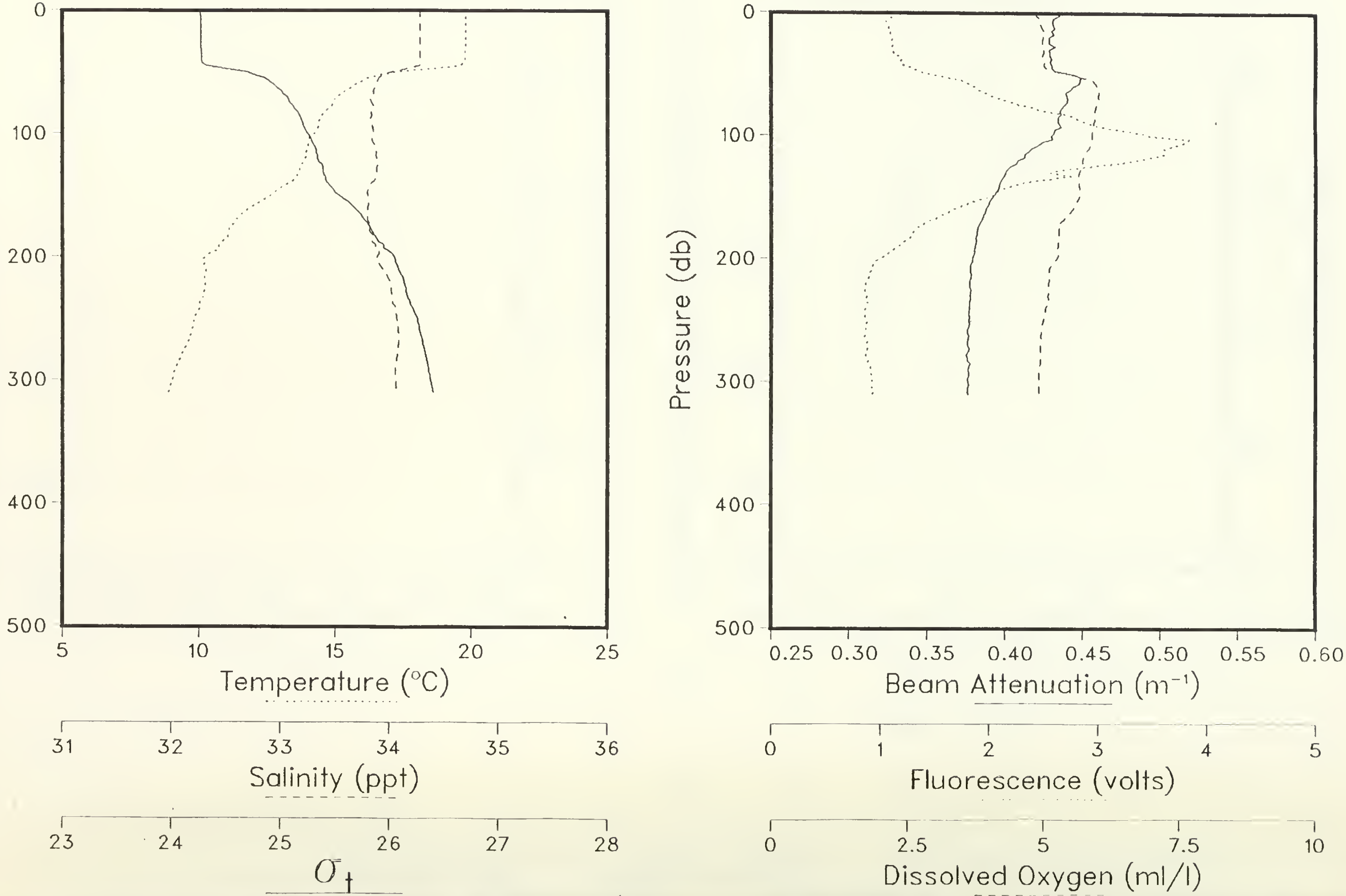
Date: 10/27/82



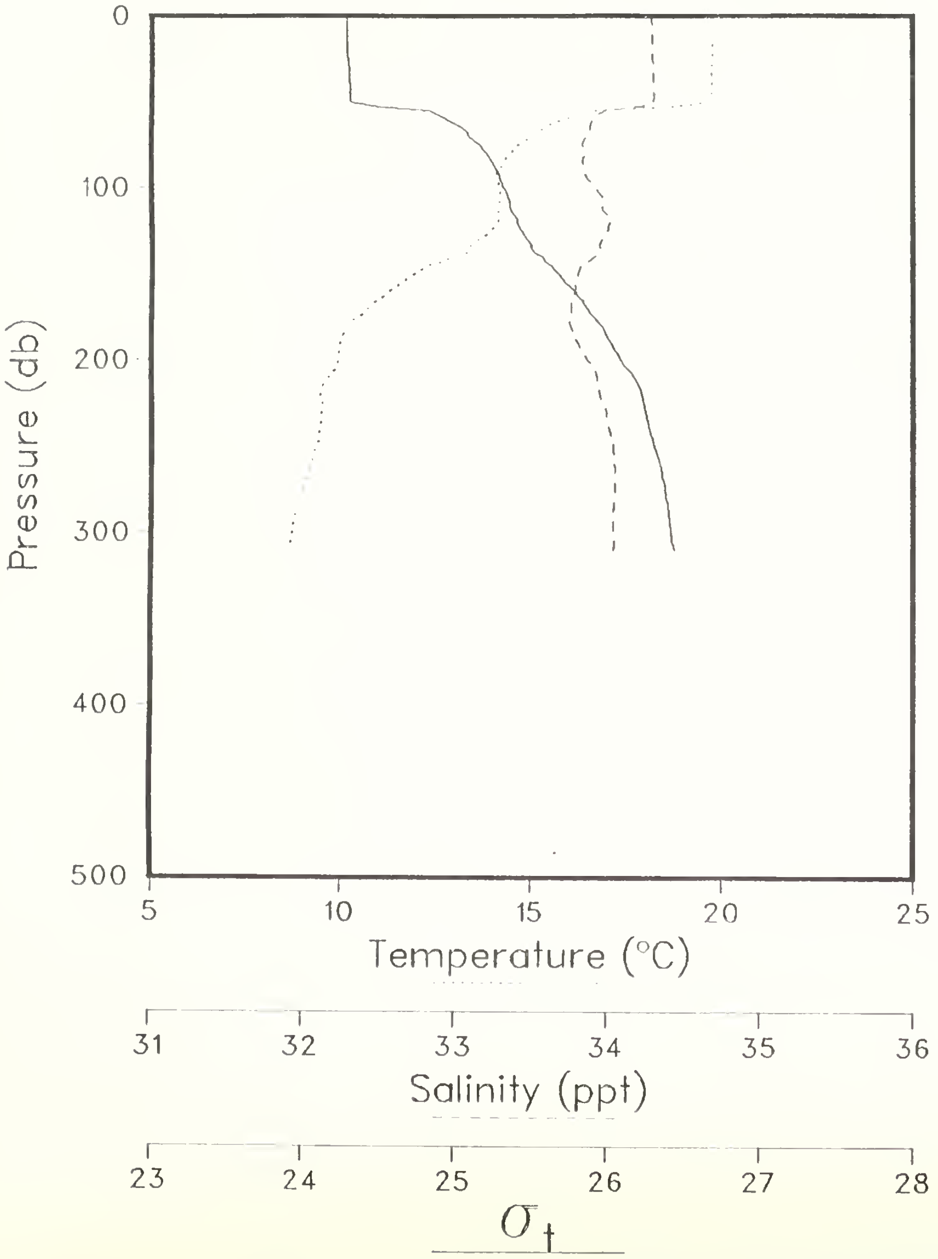


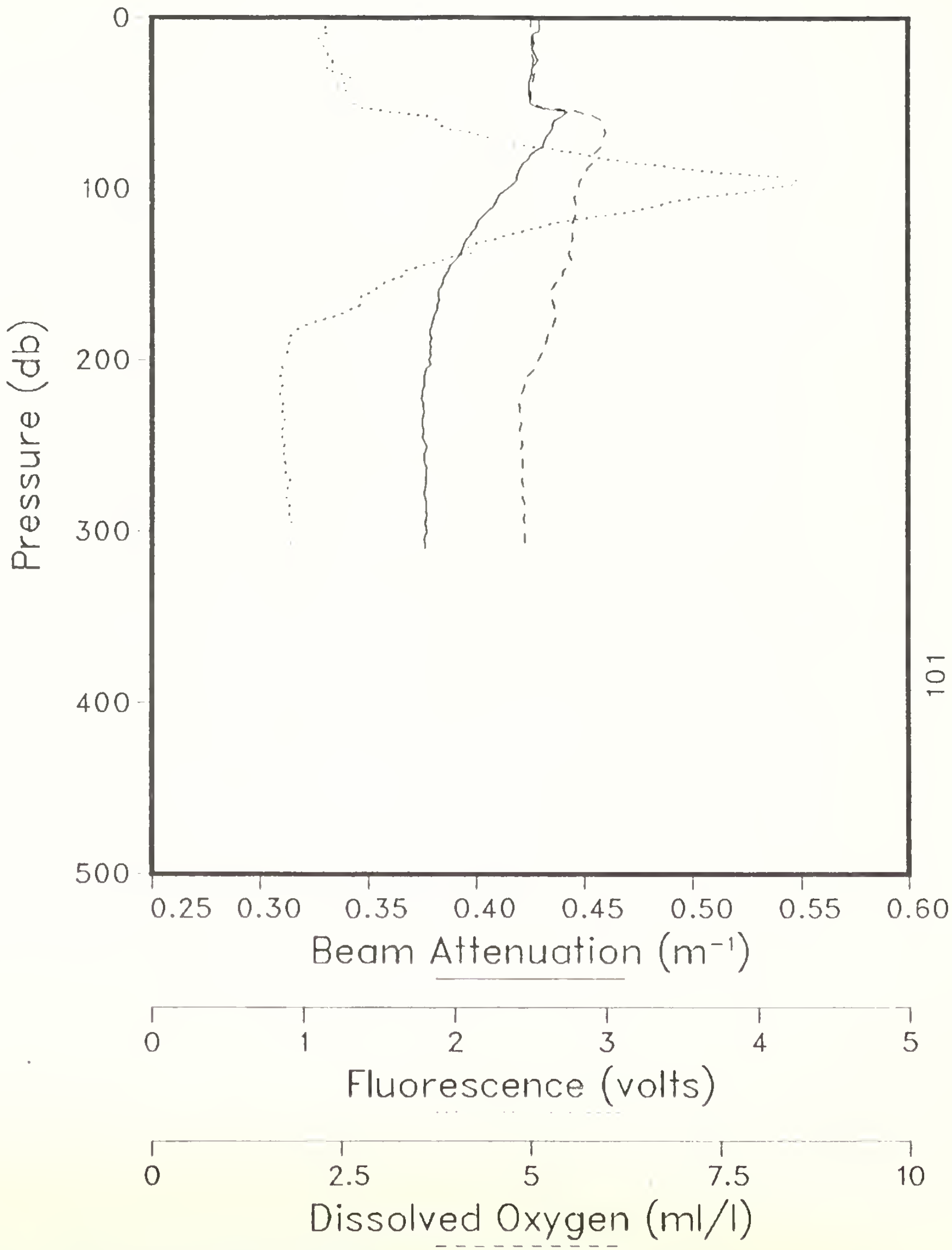
Latitude: 33.635°
Longitude: 142.105°

Date: 10/27/82
Time: 2225:46 GMT



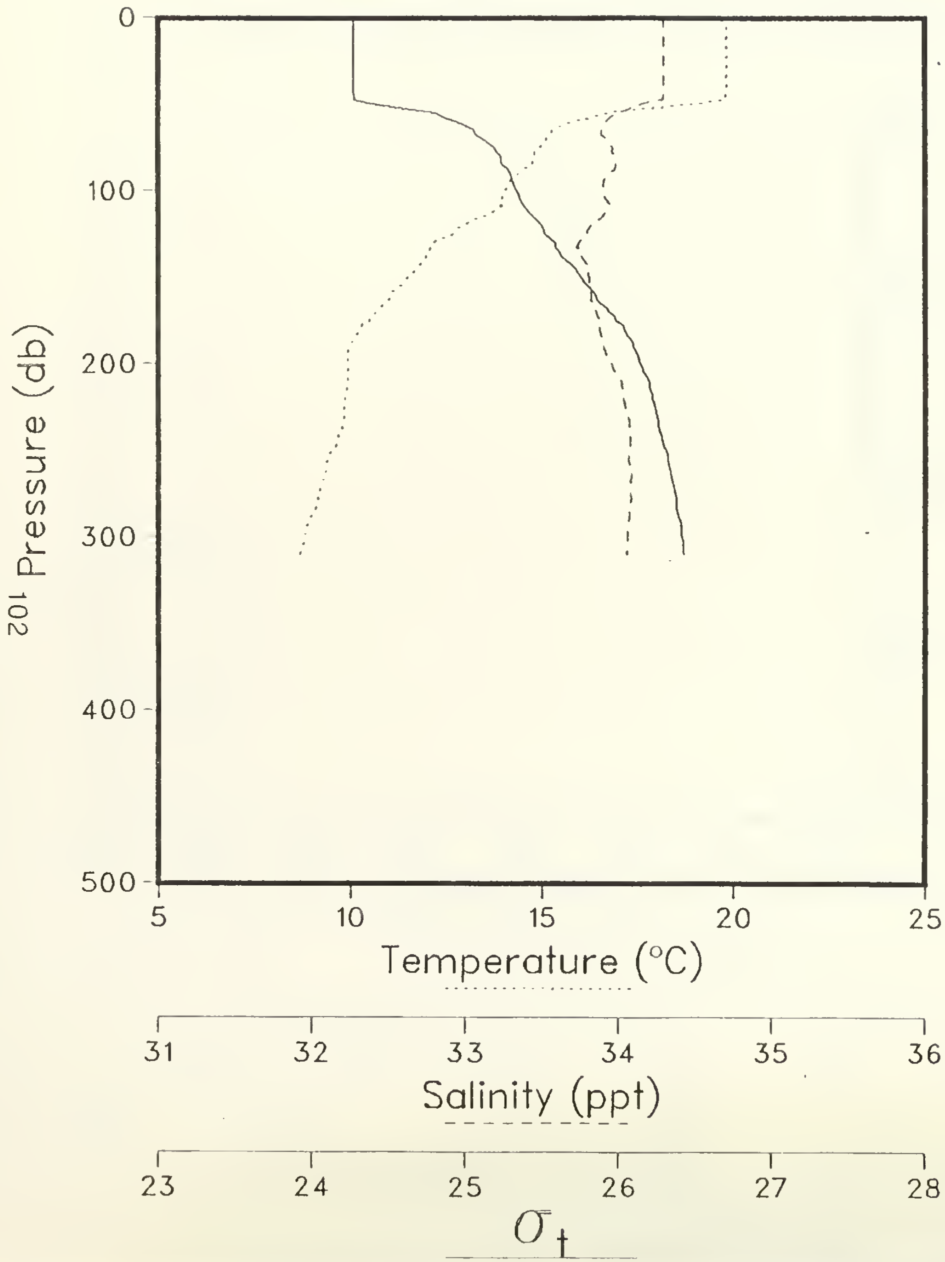
Latitude: 33.624° Date: 10/28/82

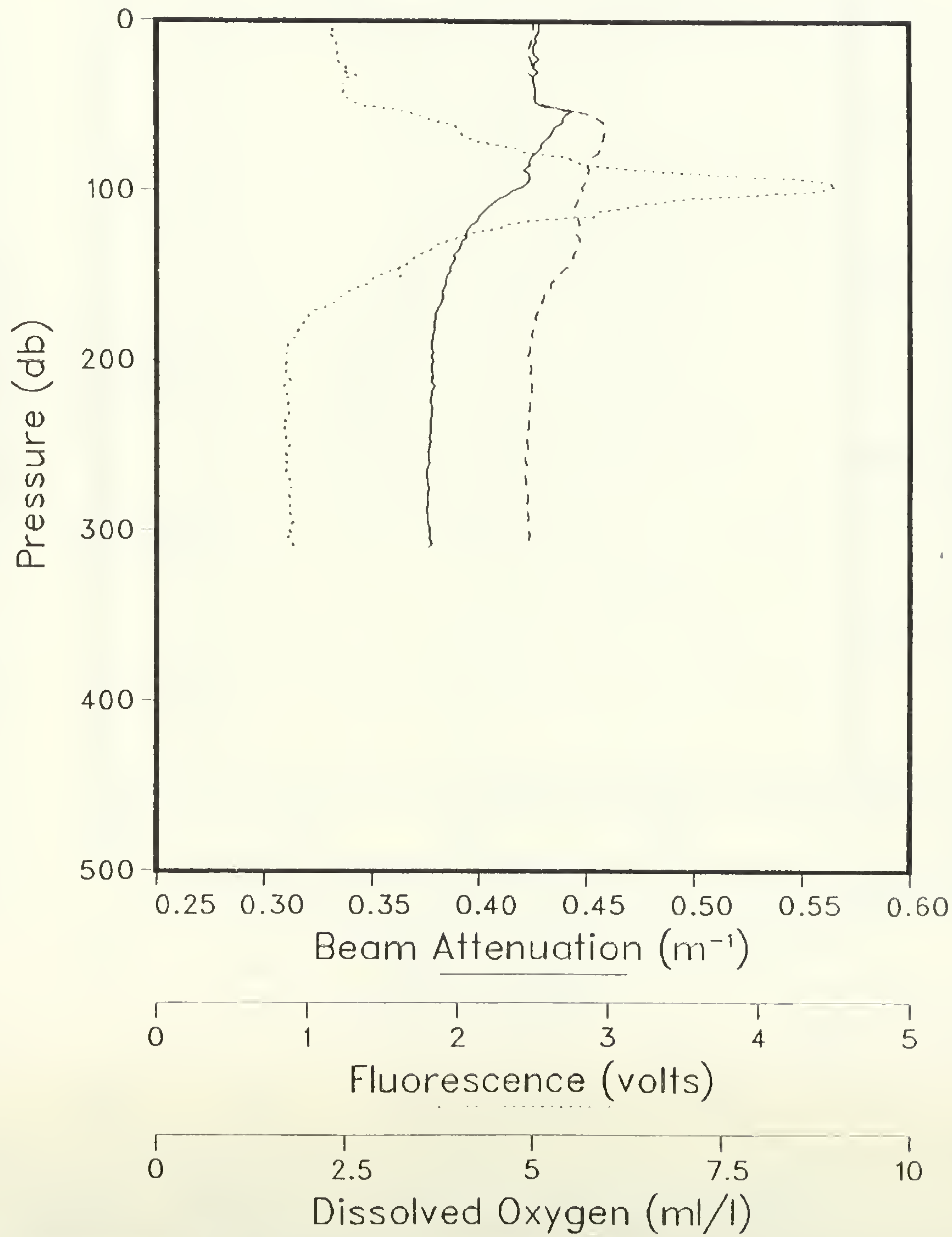




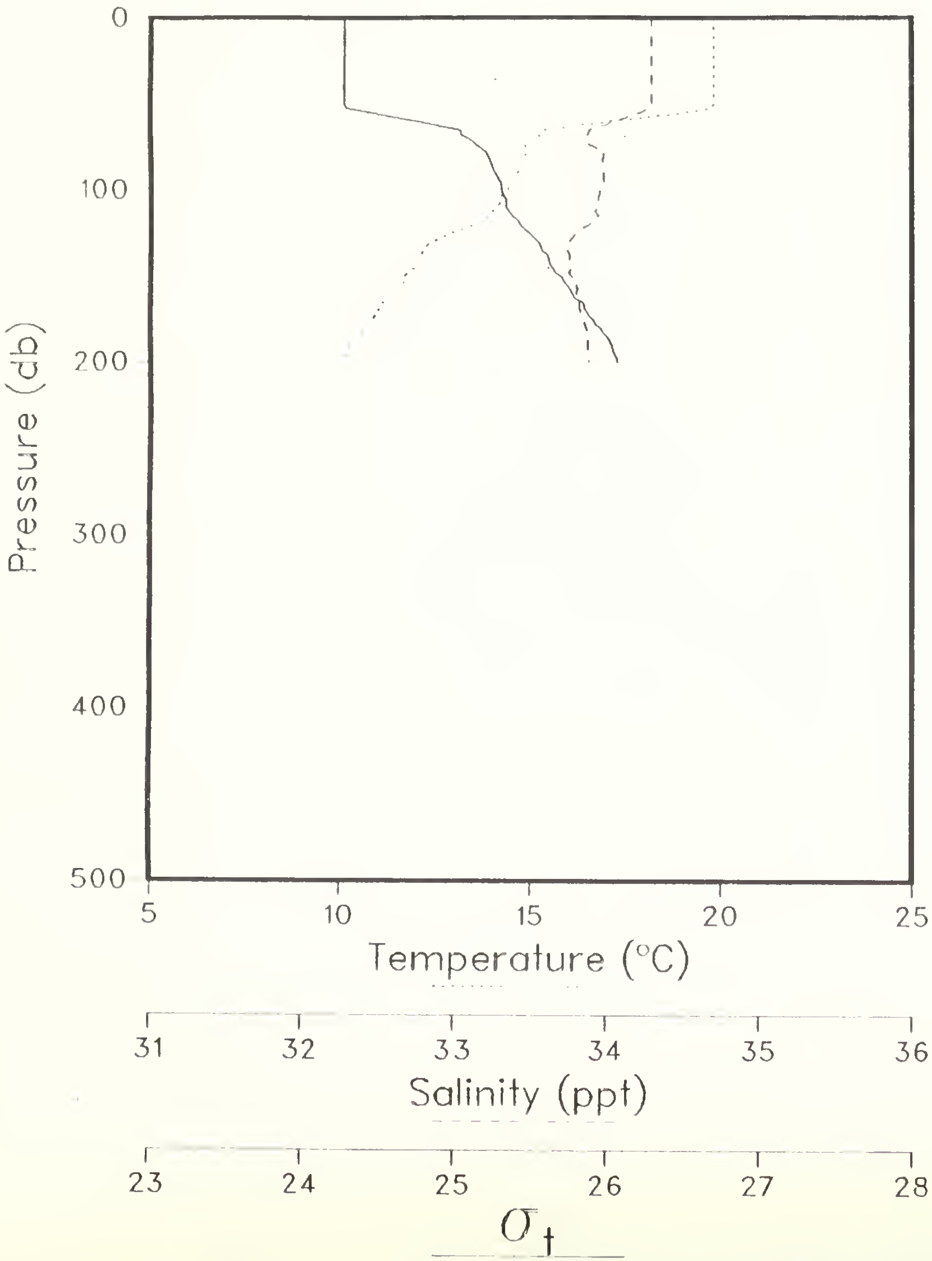
Latitude: 33.628°
Longitude: 141.806°

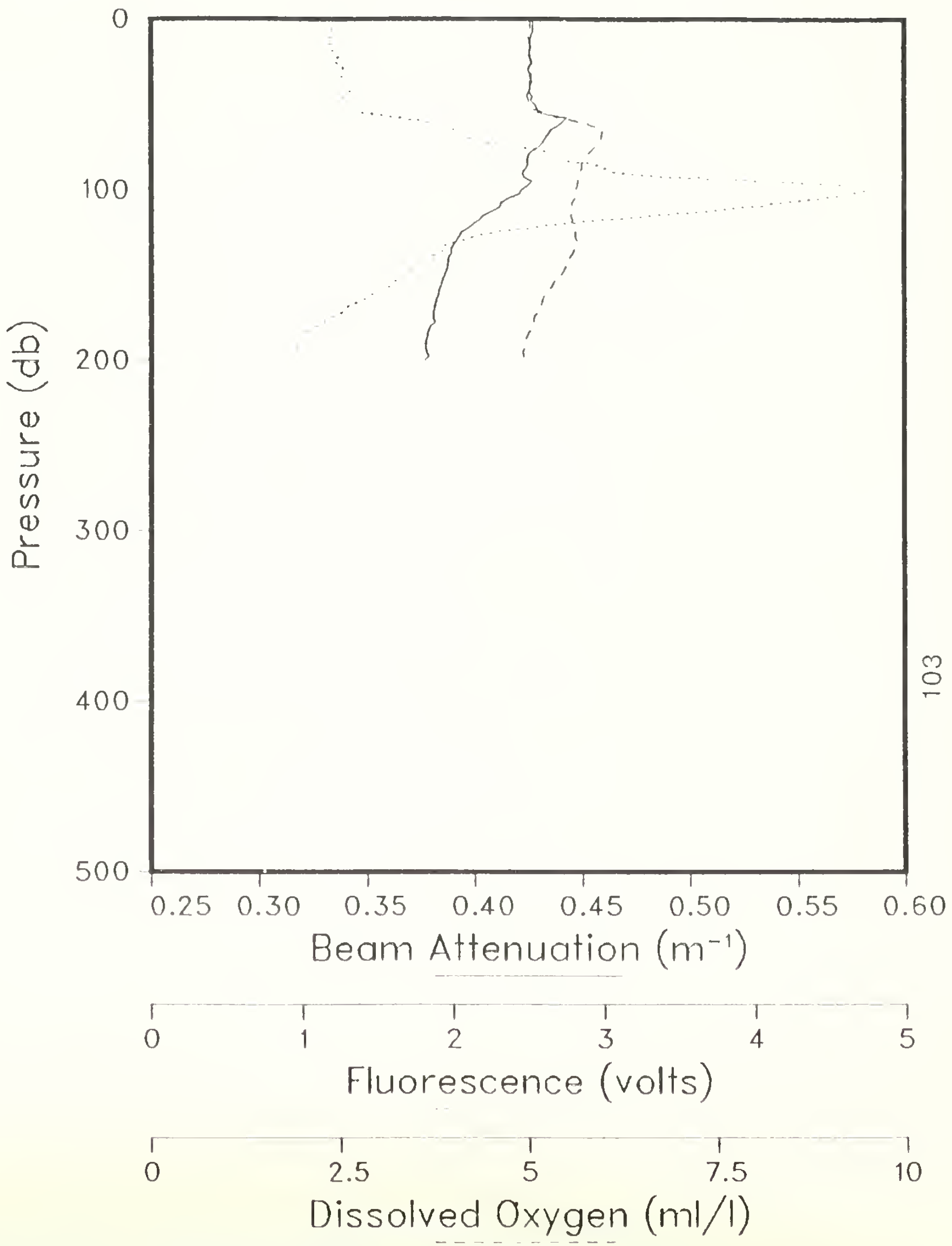
Date: 10/28/82
Time: 316:33 GMT





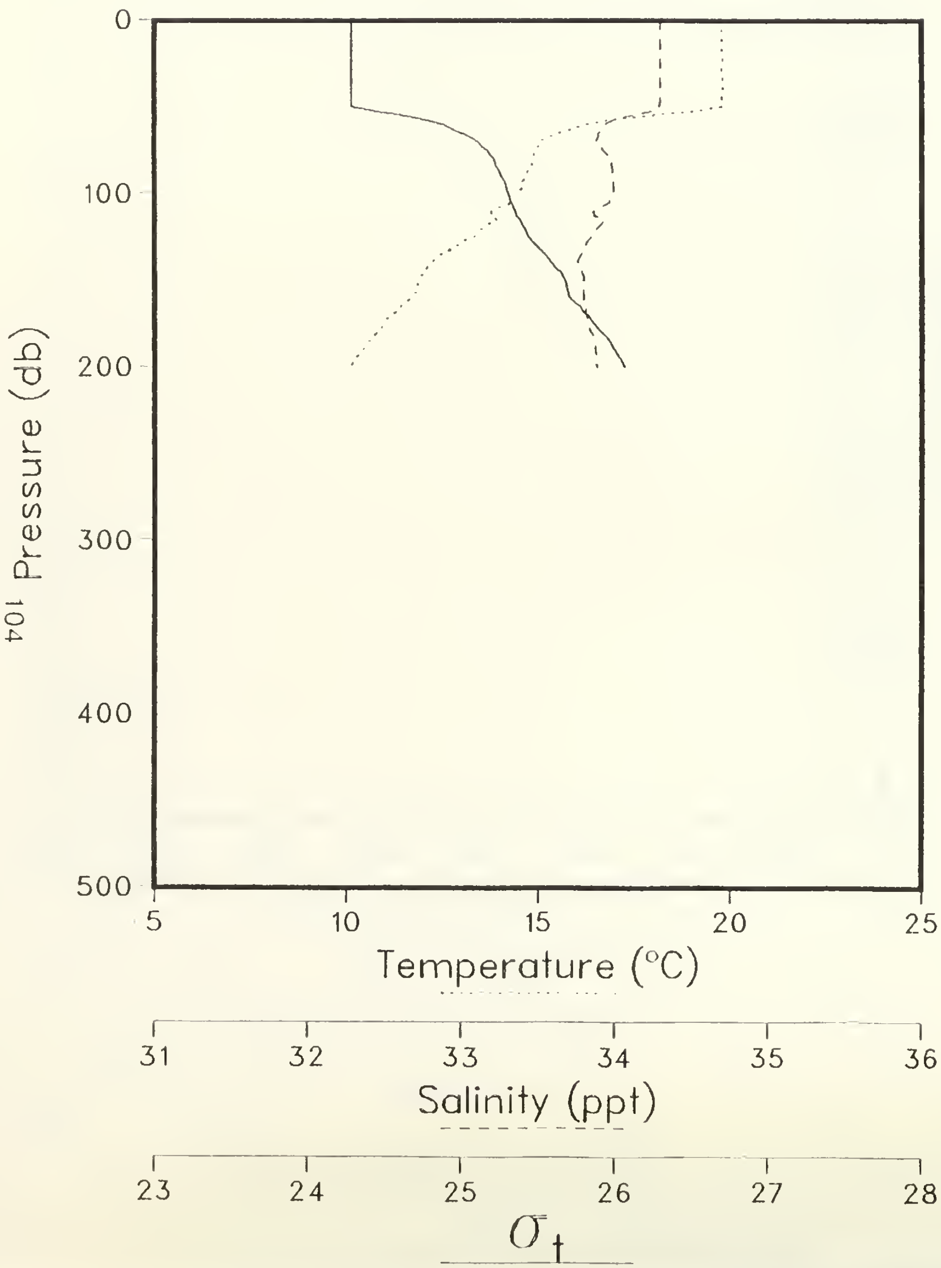
Latitude: 33.615°
Date: 10/28/82

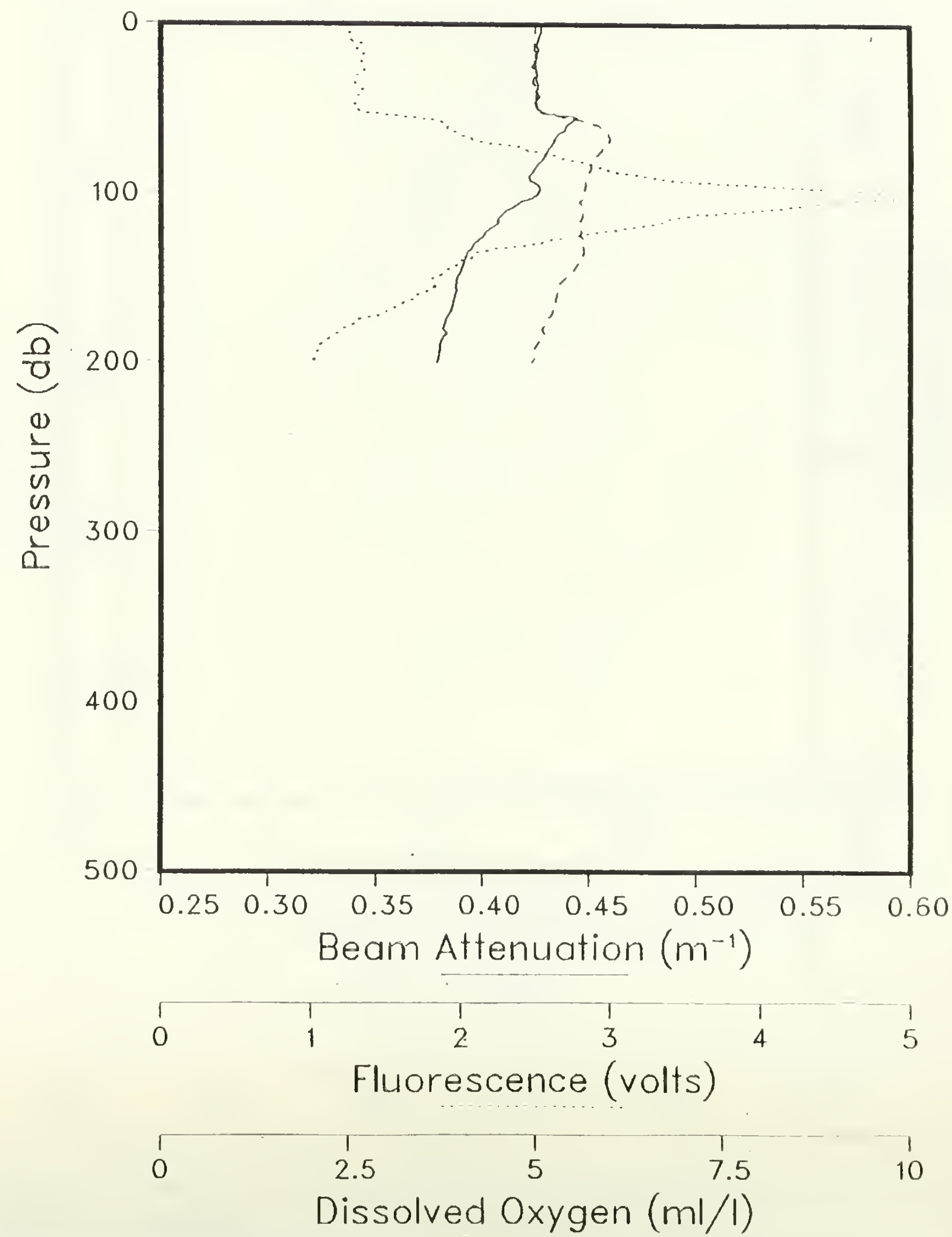




Latitude: 33.618°
Longitude: 141.722°

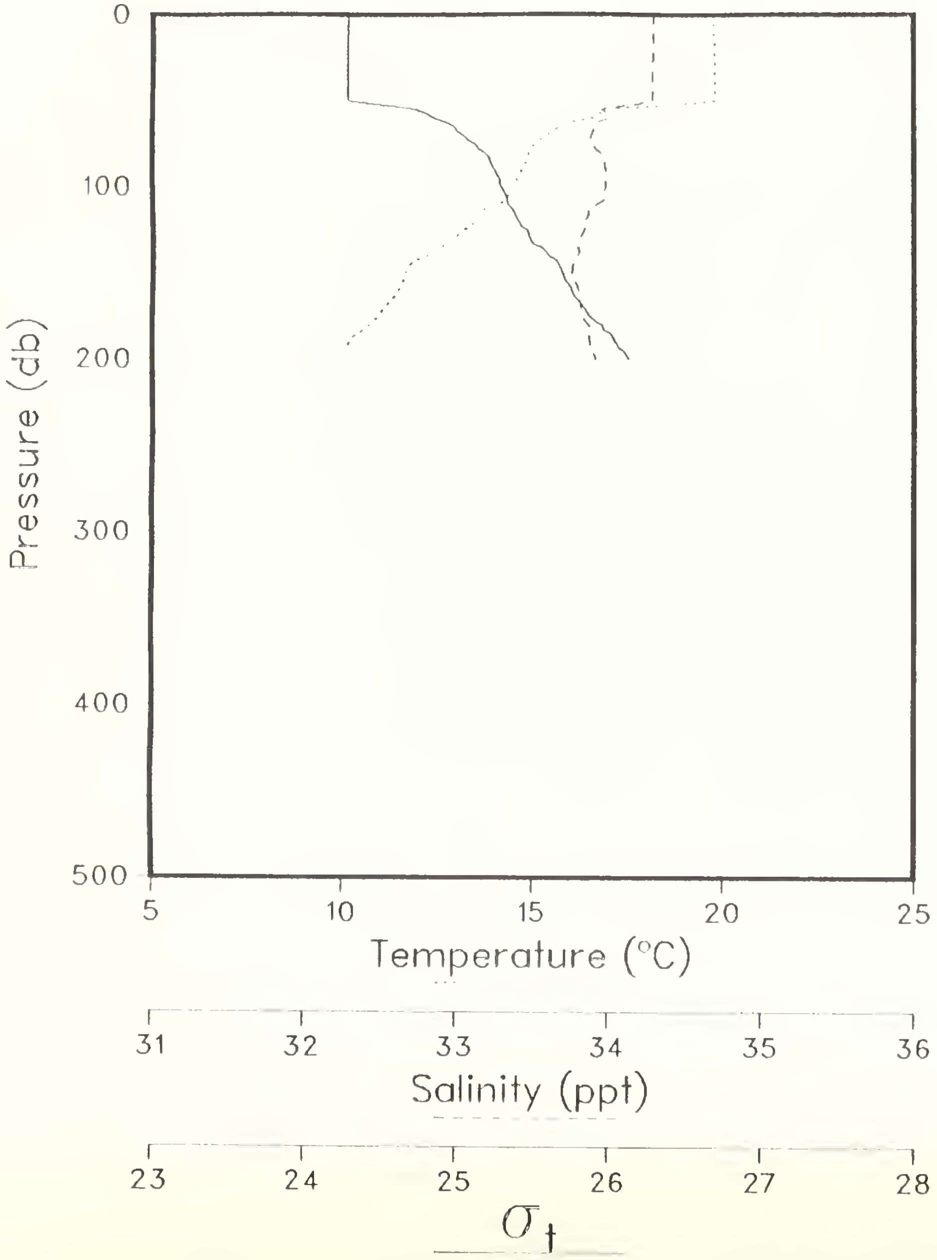
Date: 10/28/82
Time: 606:31 GMT

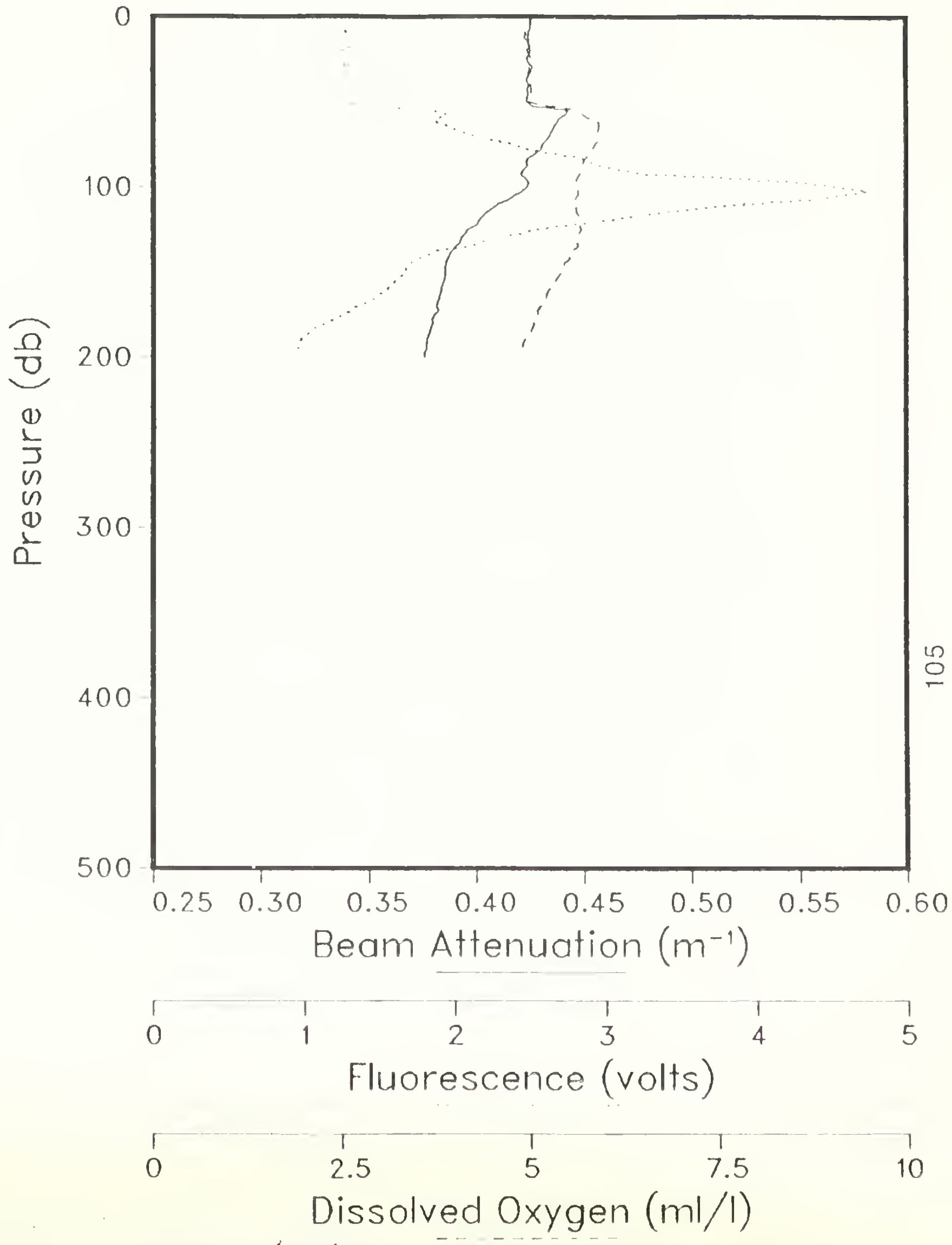




Latitude: 33.630°
Longitude: 141.723°

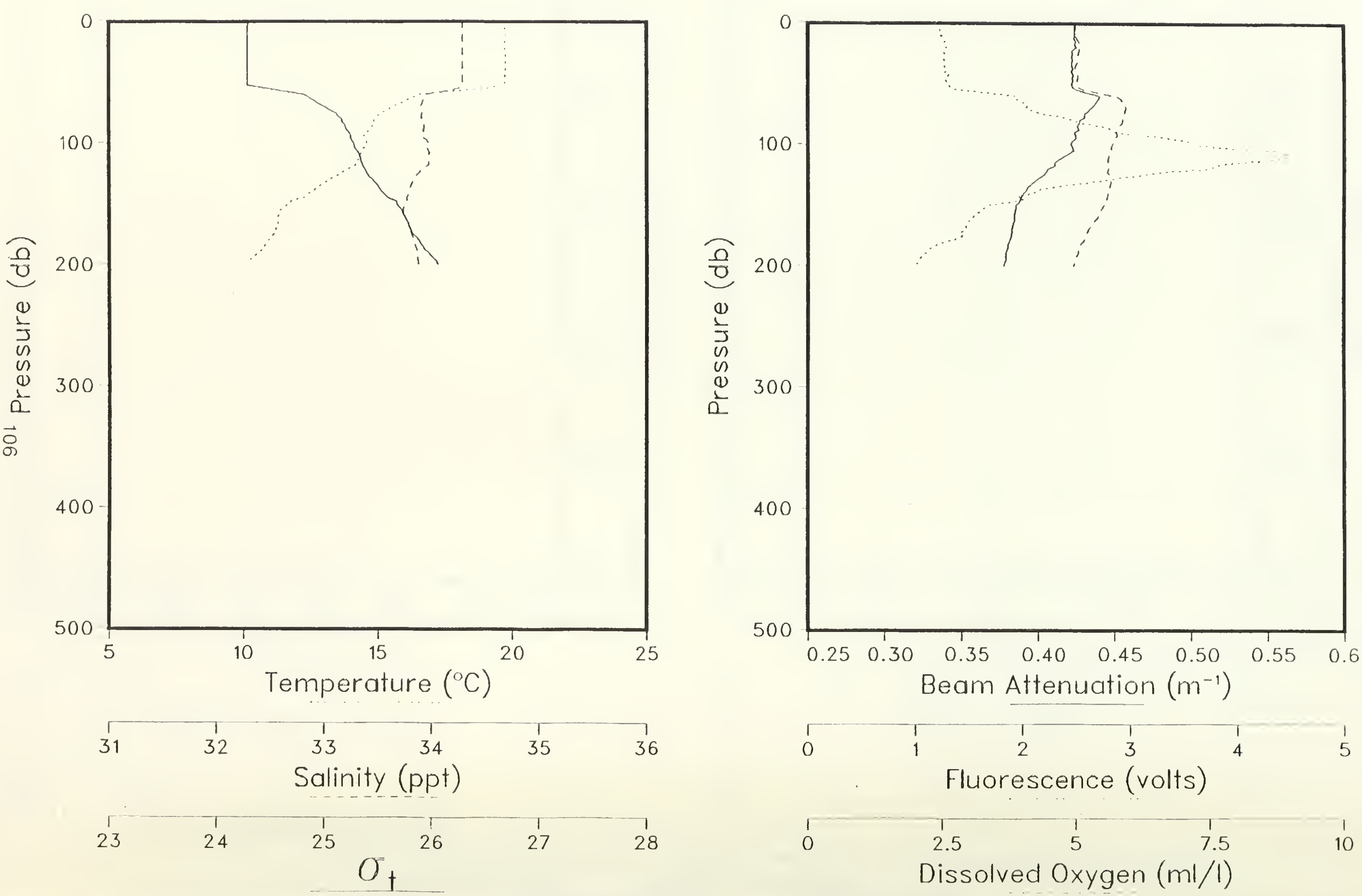
Date: 10/28/82
Time: 705:12 GMT





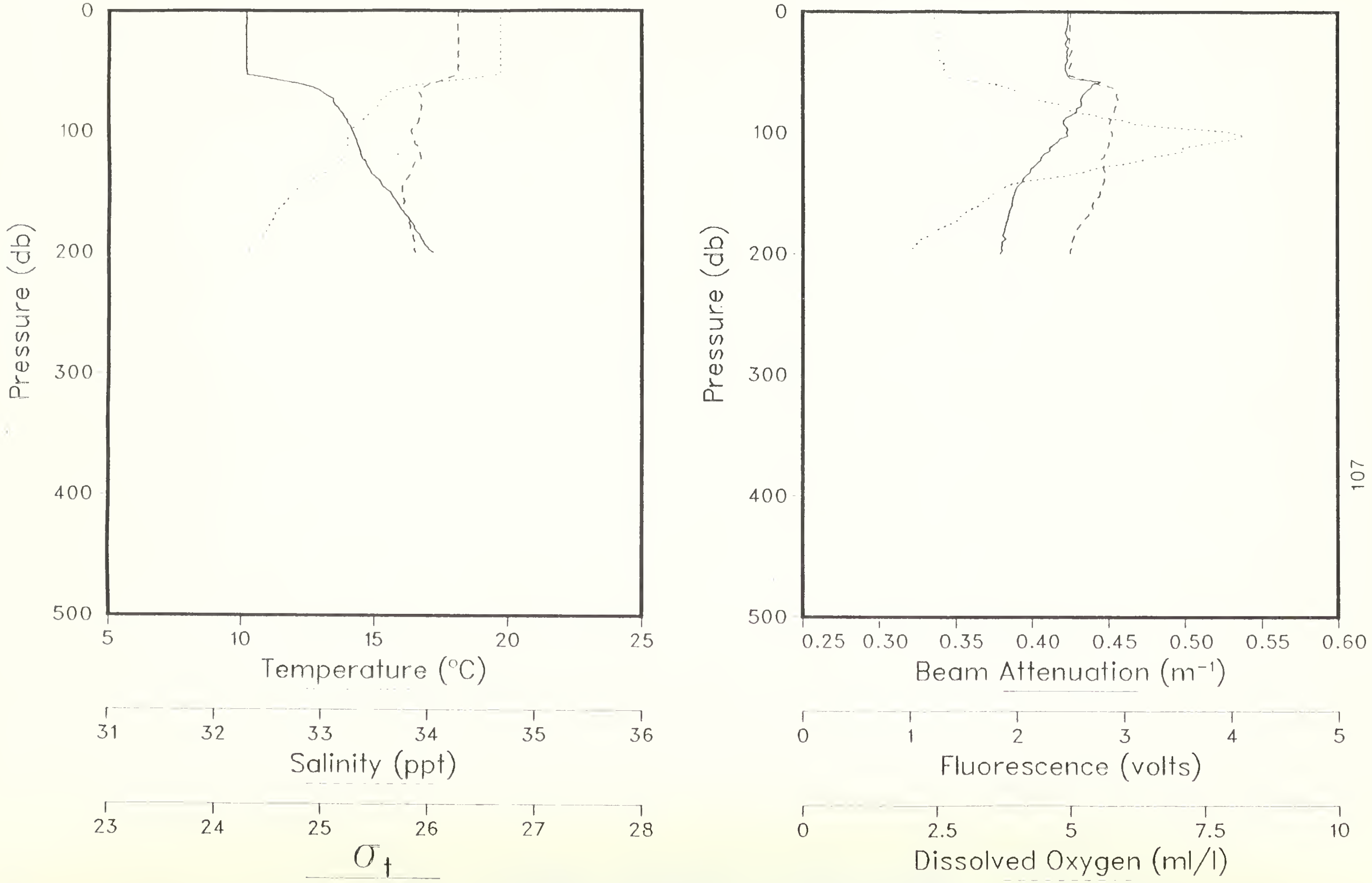
Latitude: 33.650°
Longitude: 141.703°

Date: 10/28/82
Time: 805:09 GMT



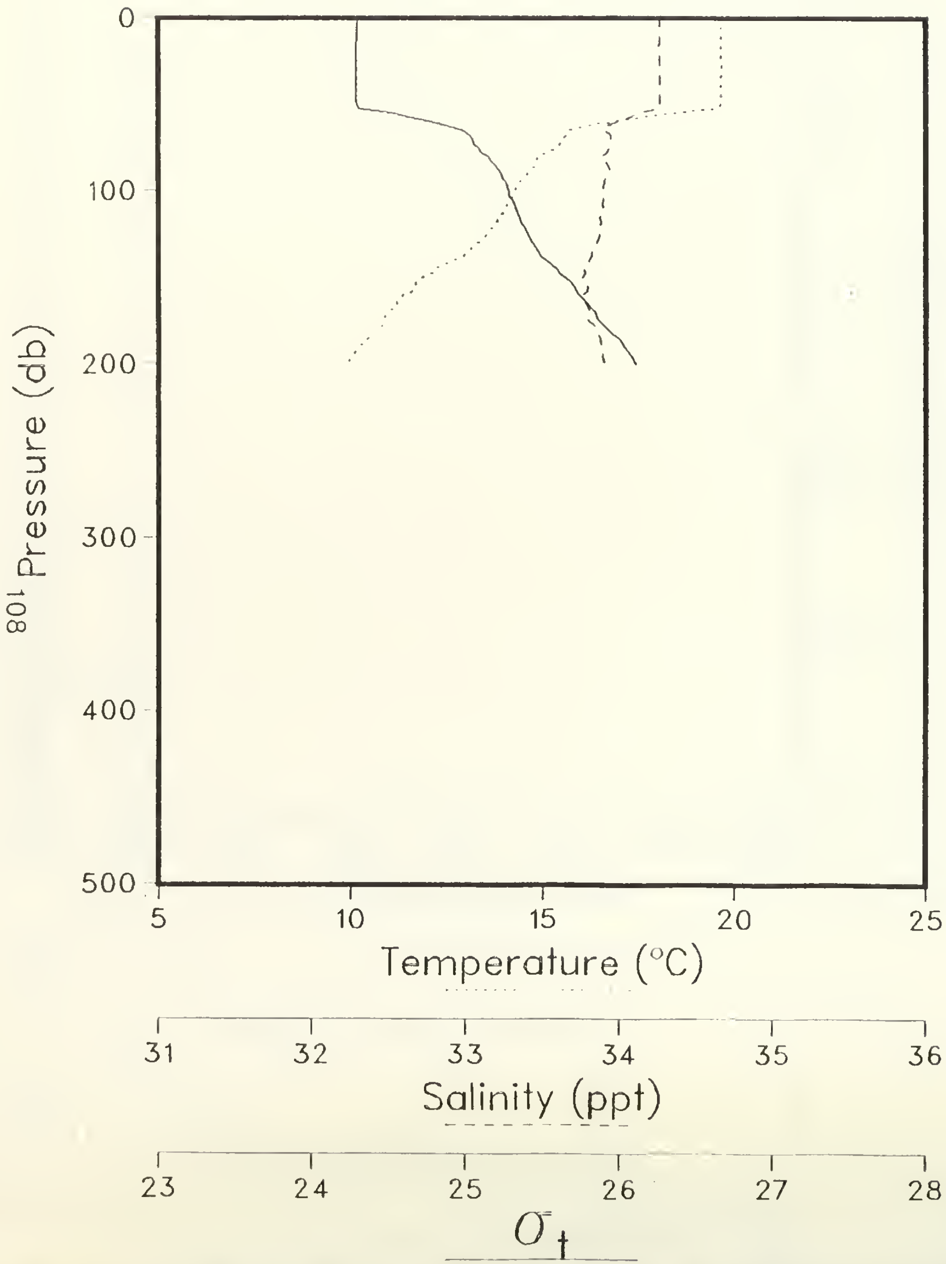
Latitude: 33.668°
Longitude: 141.685°

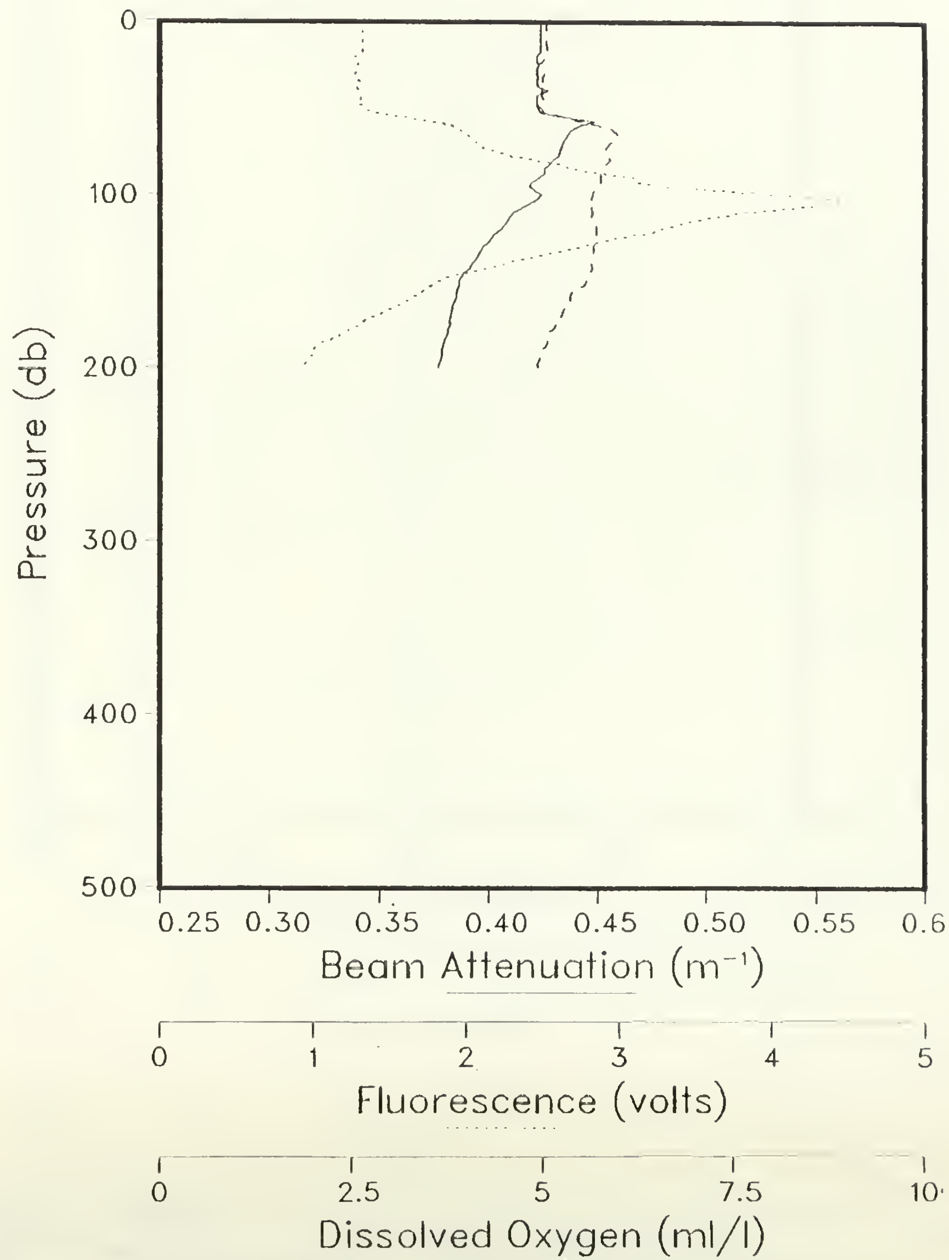
Date: 10/28/82
Time: 906:34 GMT



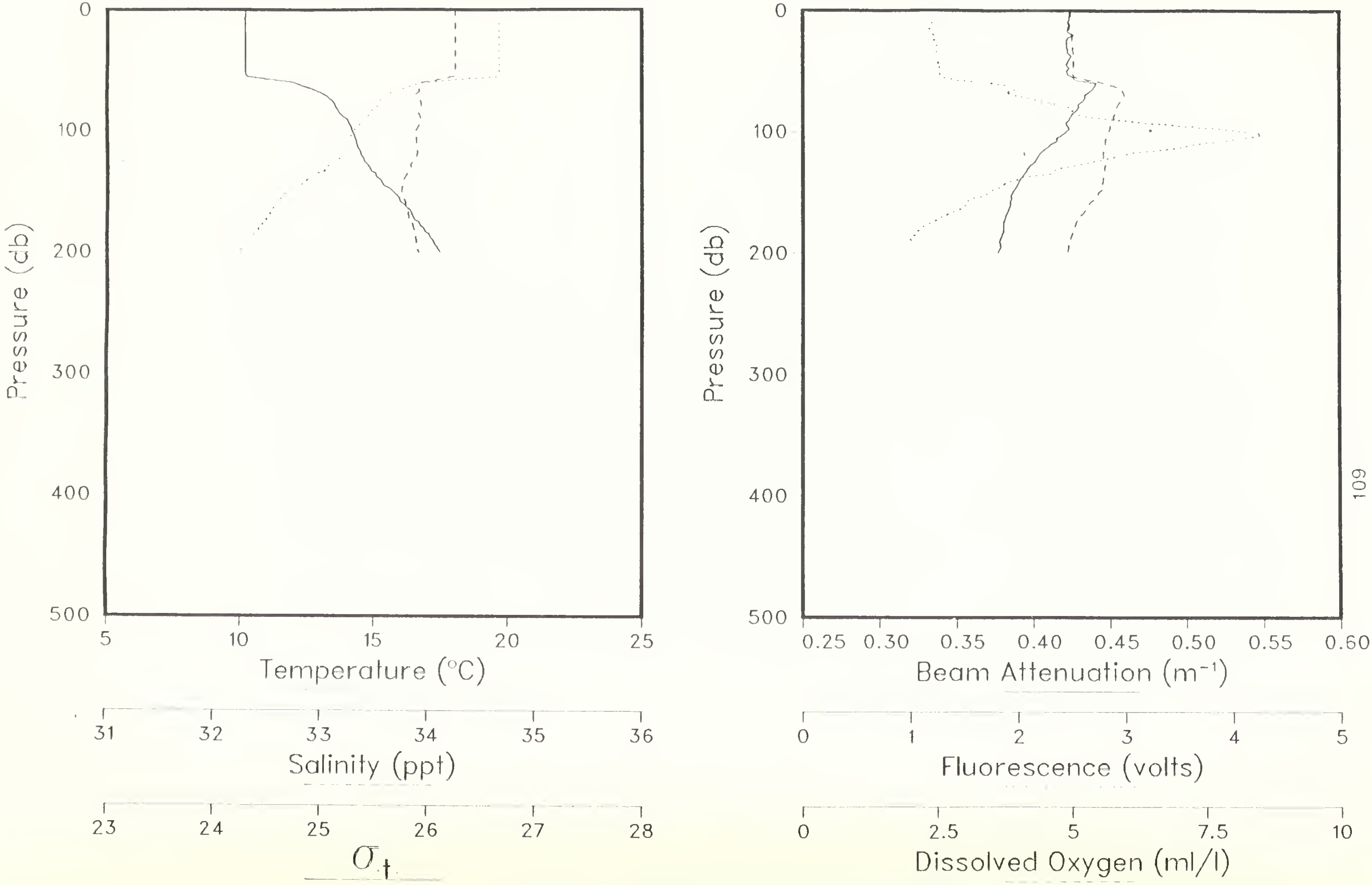
Latitude: 33.678°
Longitude: 141.678°

Date: 10/28/82
Time: 1006:54 GMT





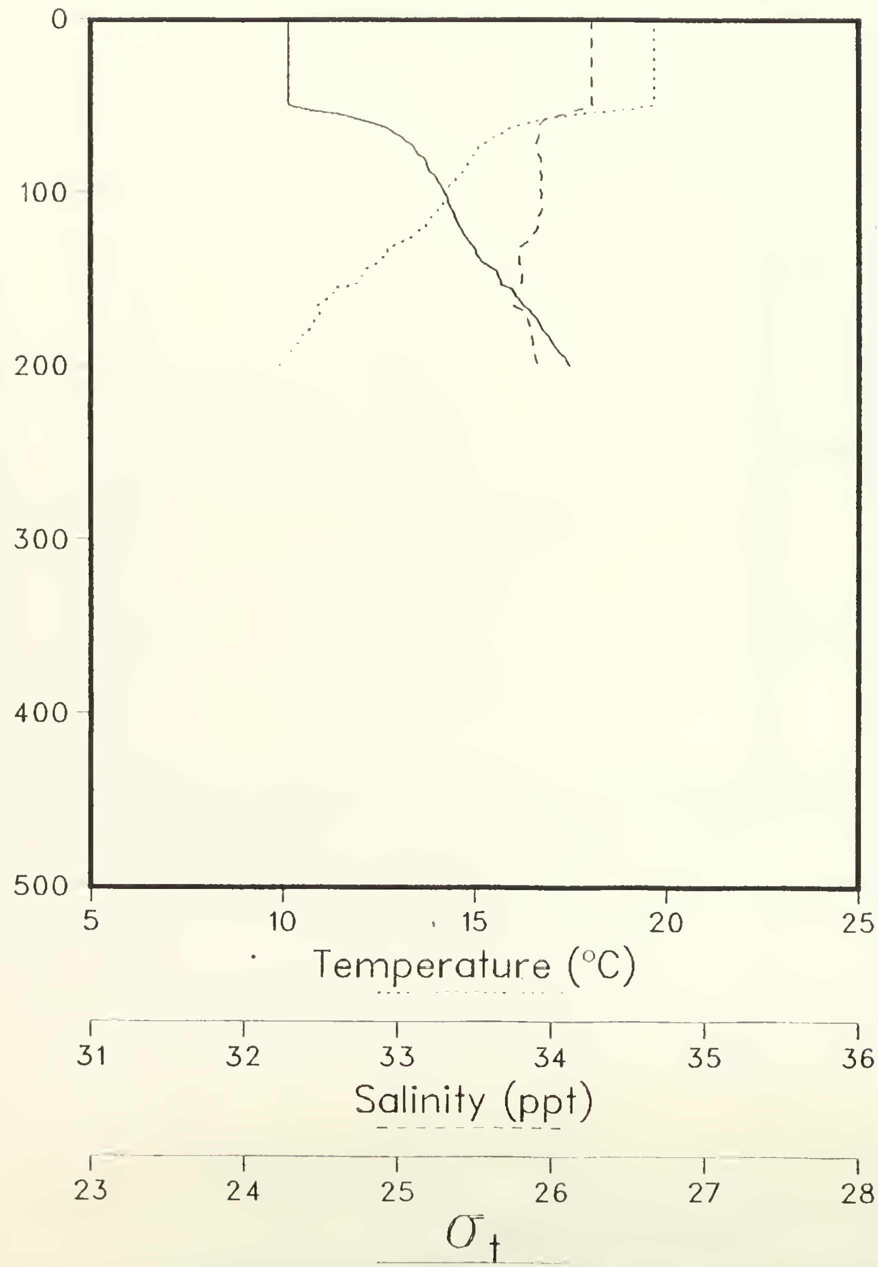
Latitude: 33.692° Date: 10/28/82

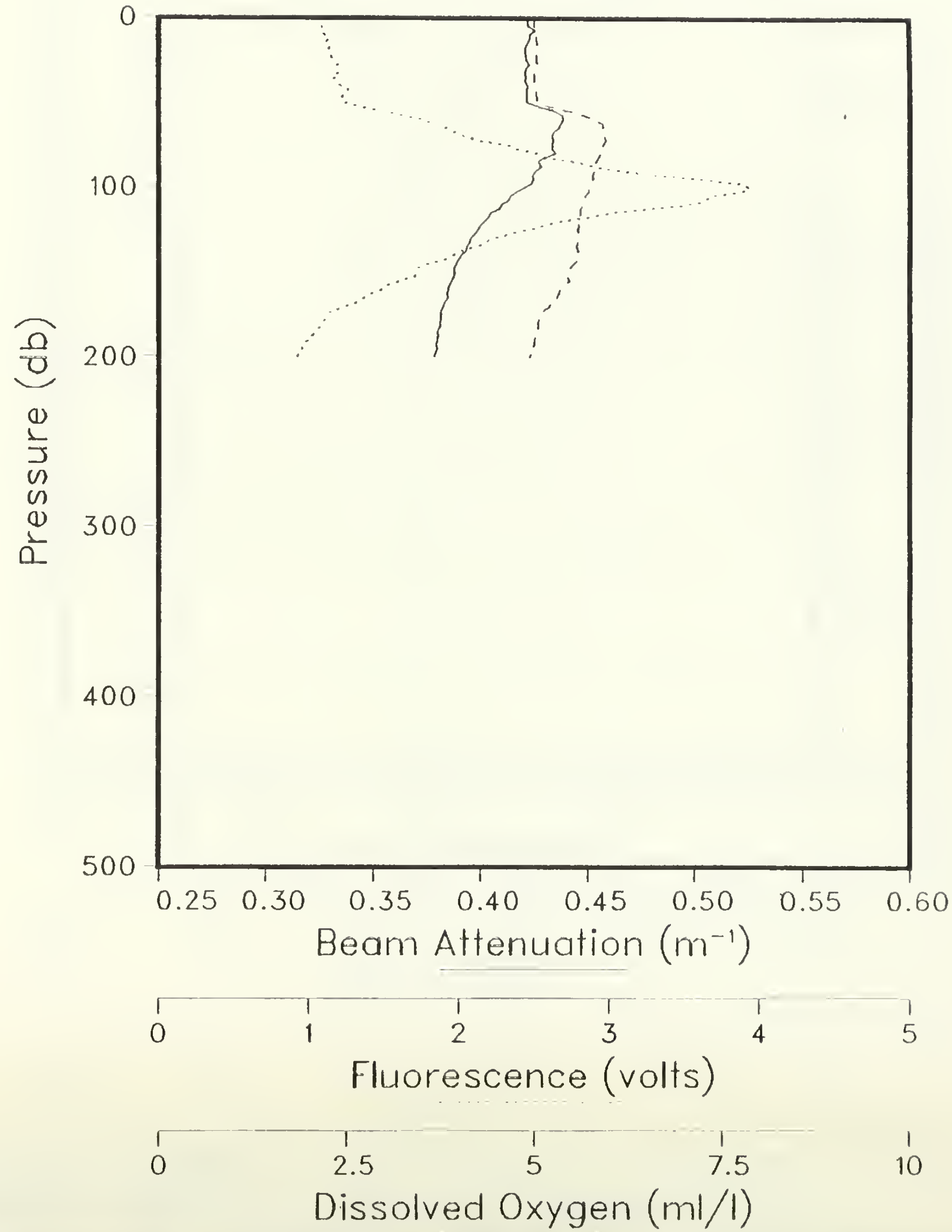


Latitude: 33.700°
Longitude: 141.663°

Date: 10/28/82
Time: 1205:58 GMT

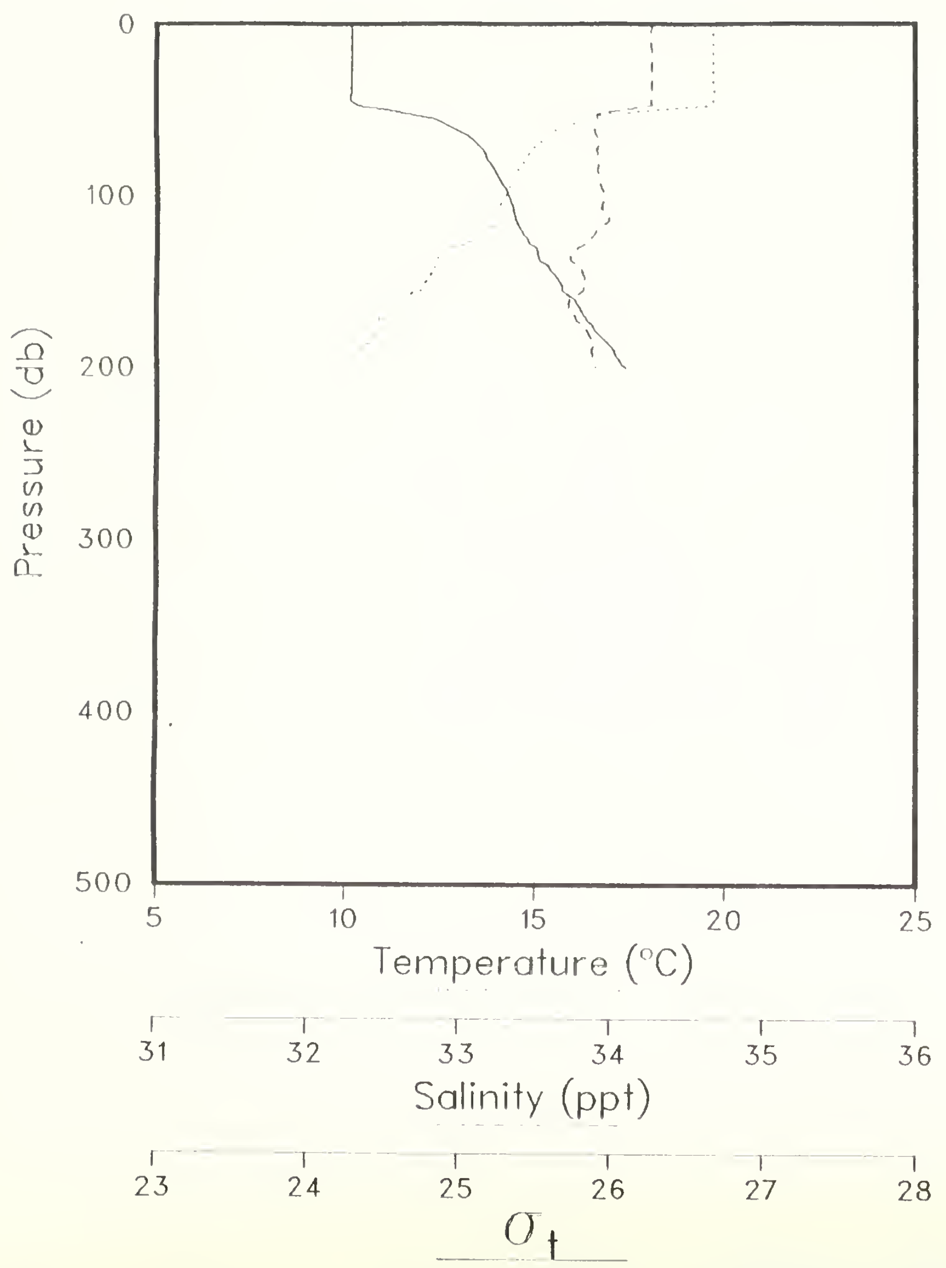
R/V ACANIA CRUISE ODEX3, STATION G1M

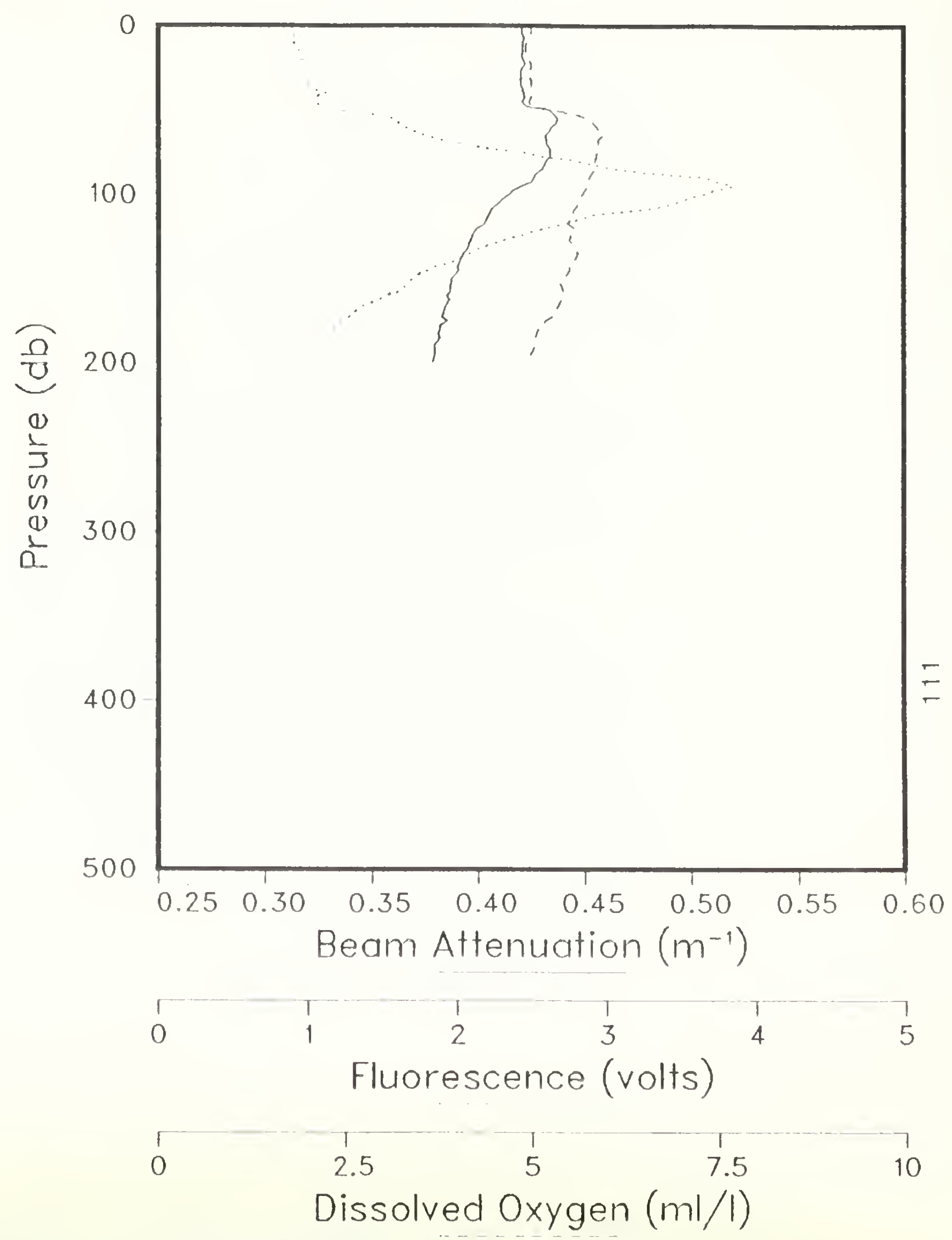




Latitude: 33.712°

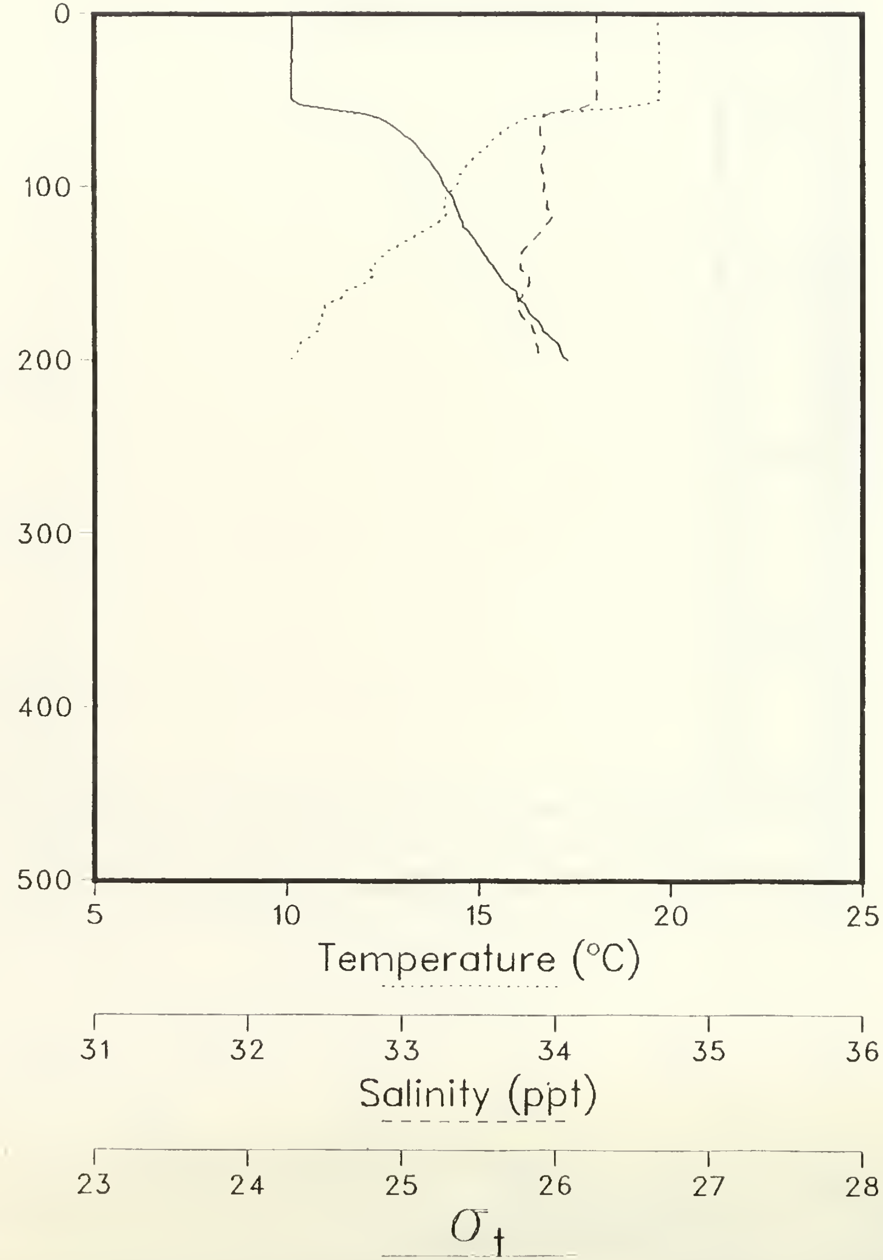
Date: 10/28/82

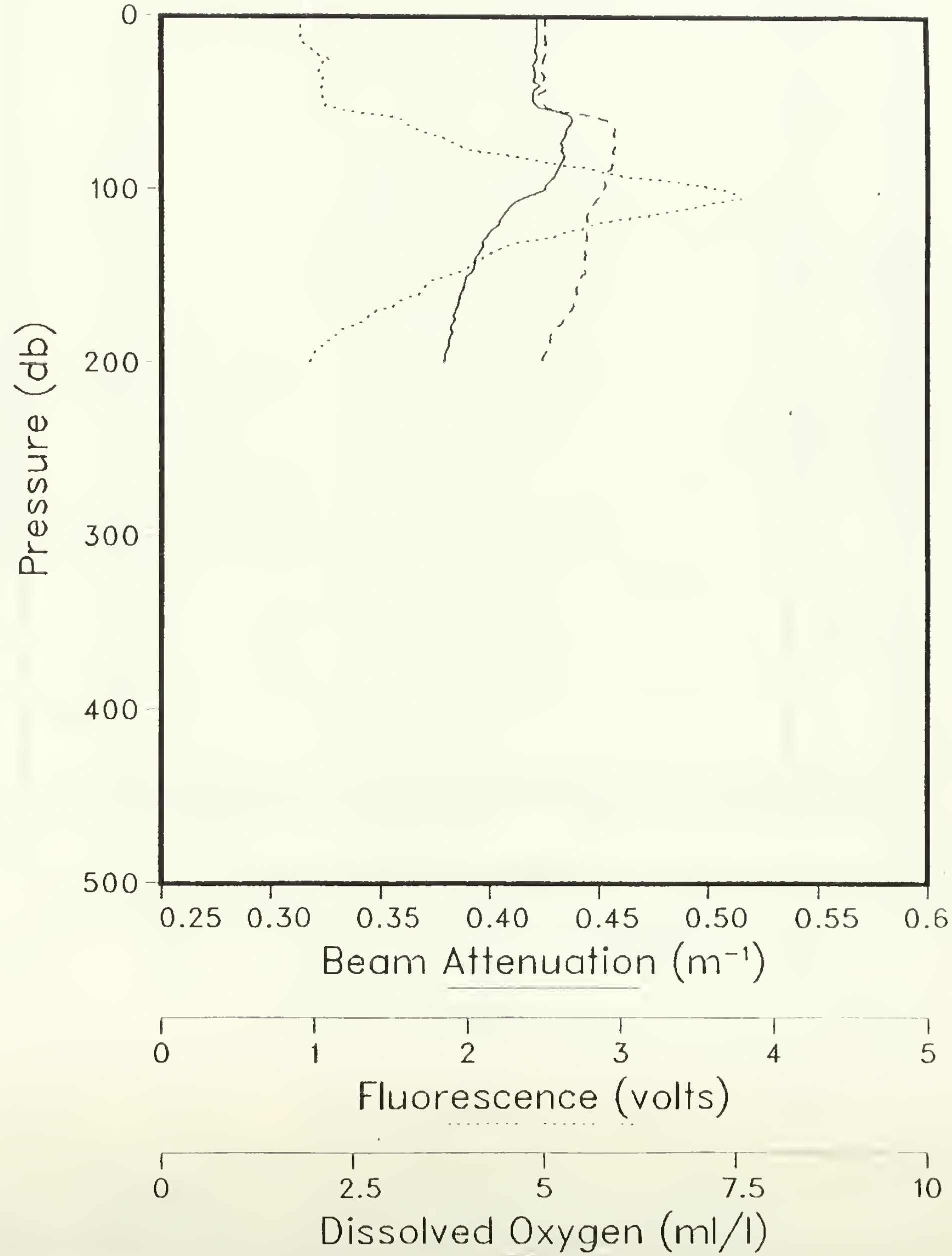




Latitude: 33.723°
Longitude: 141.648°

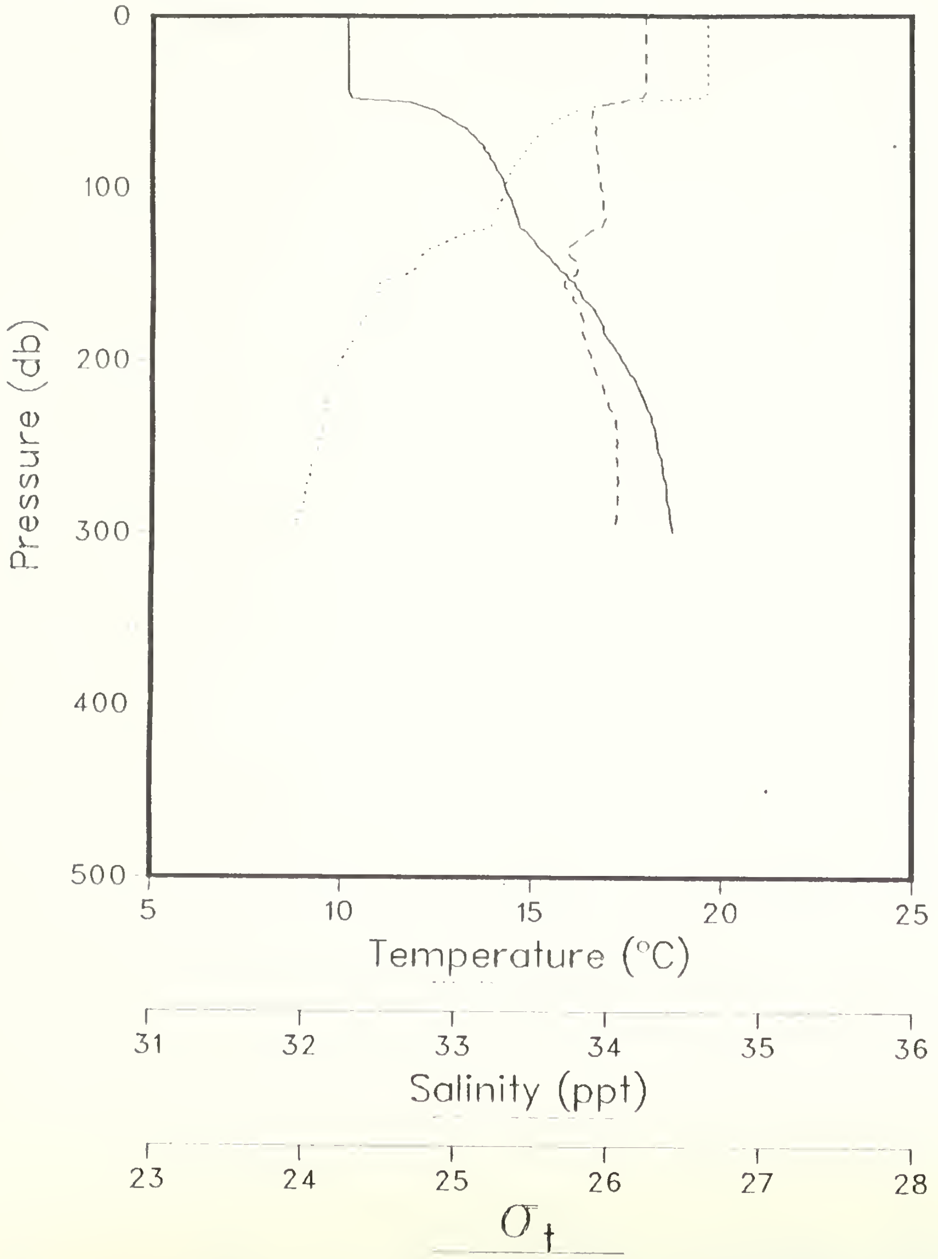
Date: 10/28/82
Time: 1405:45 GMT

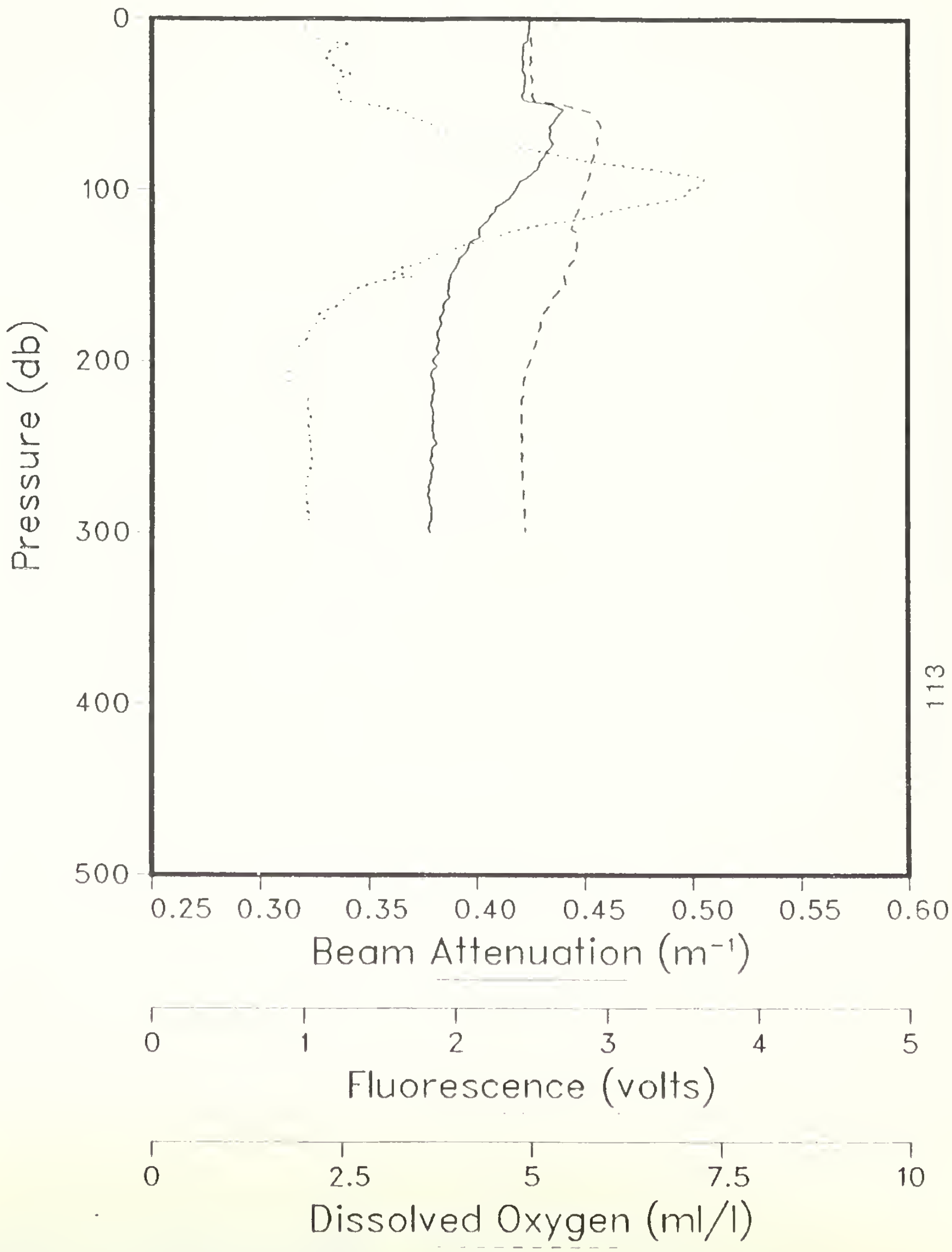




Latitude: 33.735°
Longitude: 141.640°

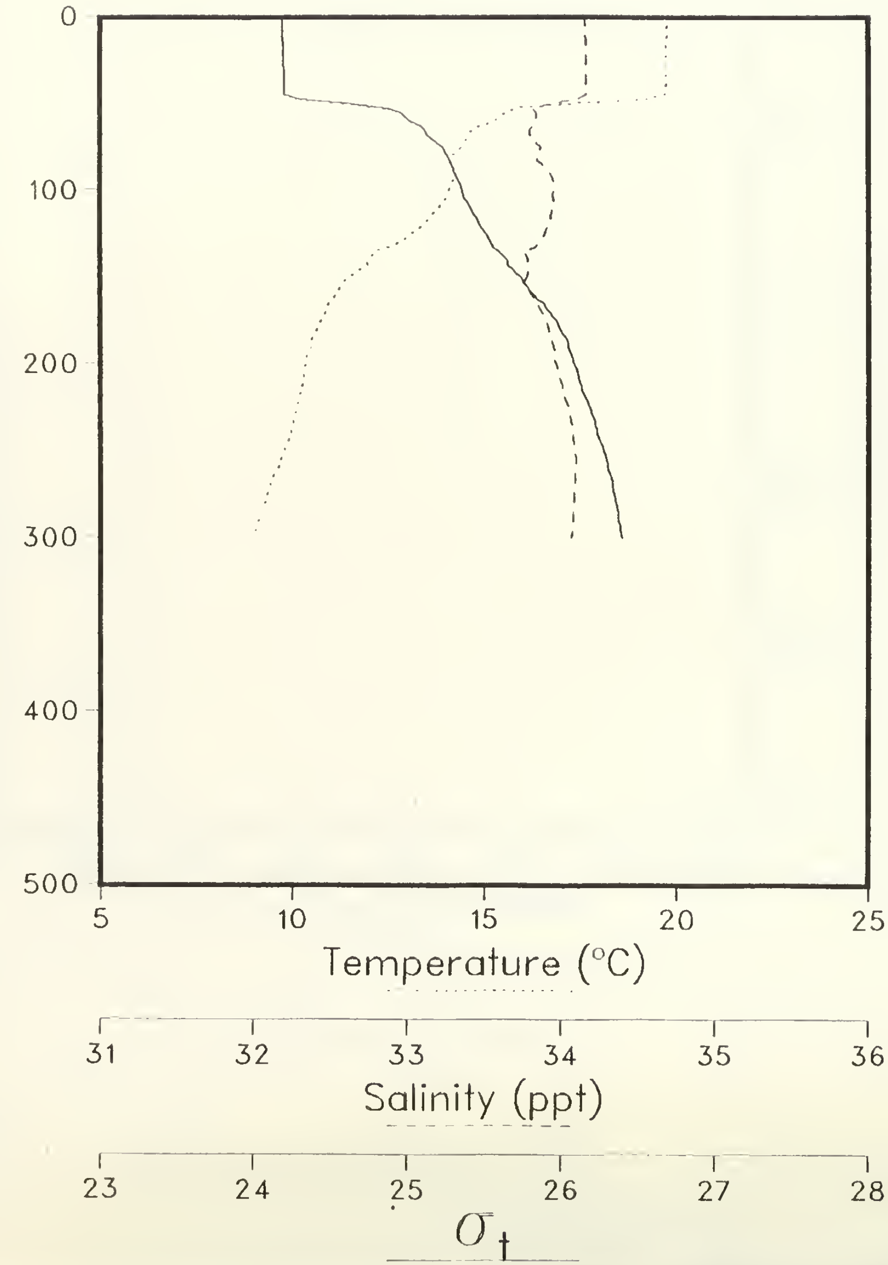
Date: 10/28/82
Time: 1504:58 GMT

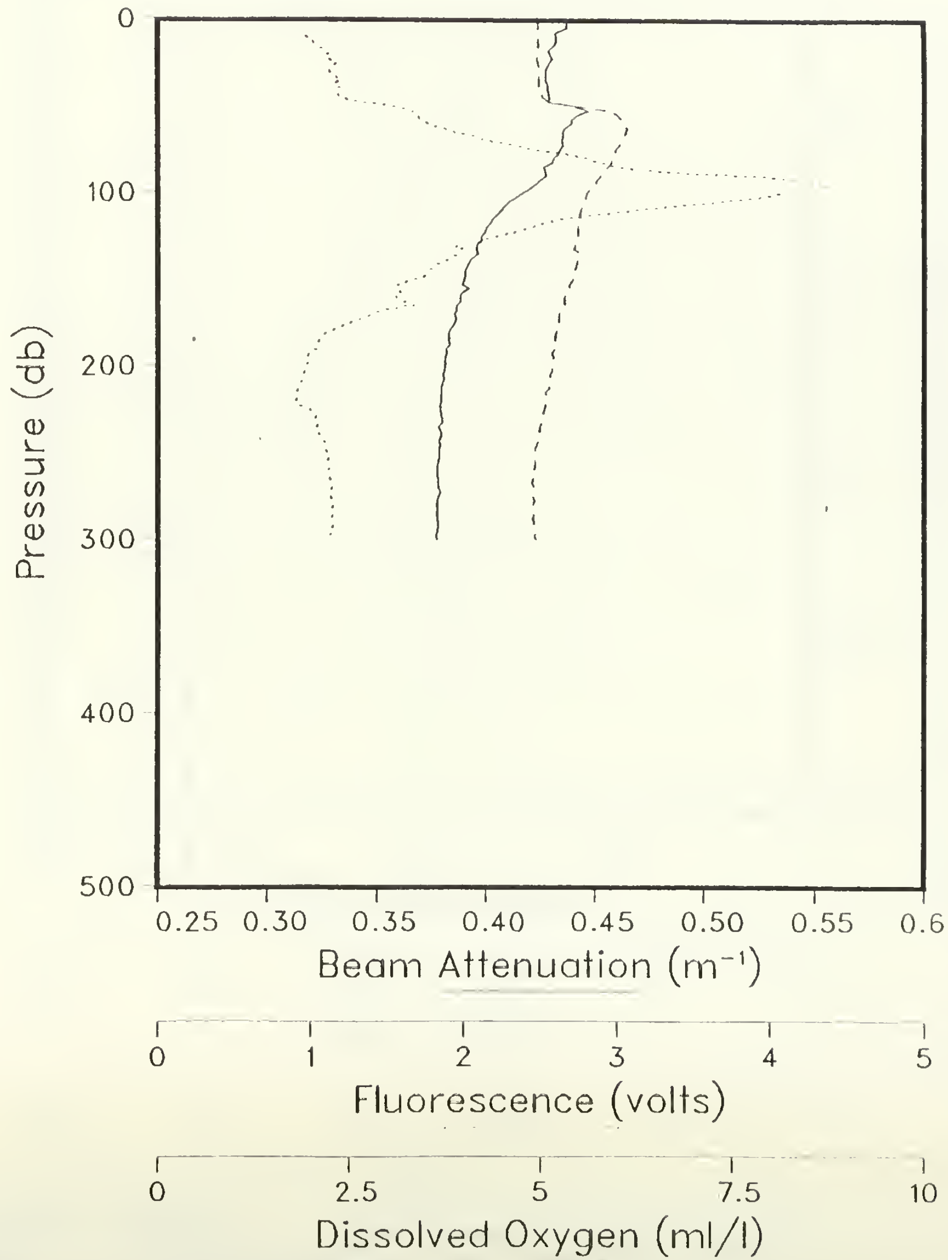




Latitude: 33.761°
Longitude: 141.622°

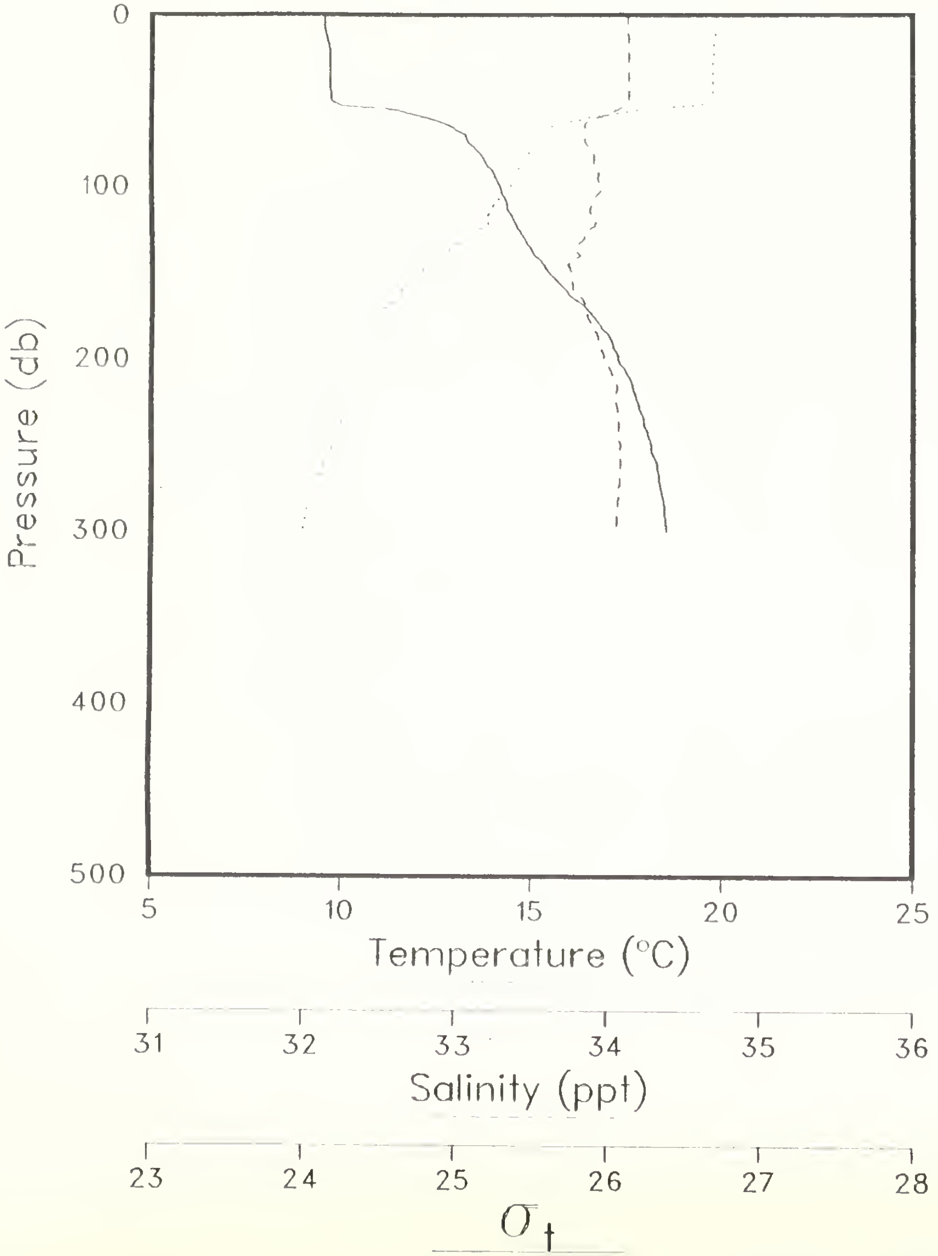
Date: 10/28/82
Time: 1718:58 GMT

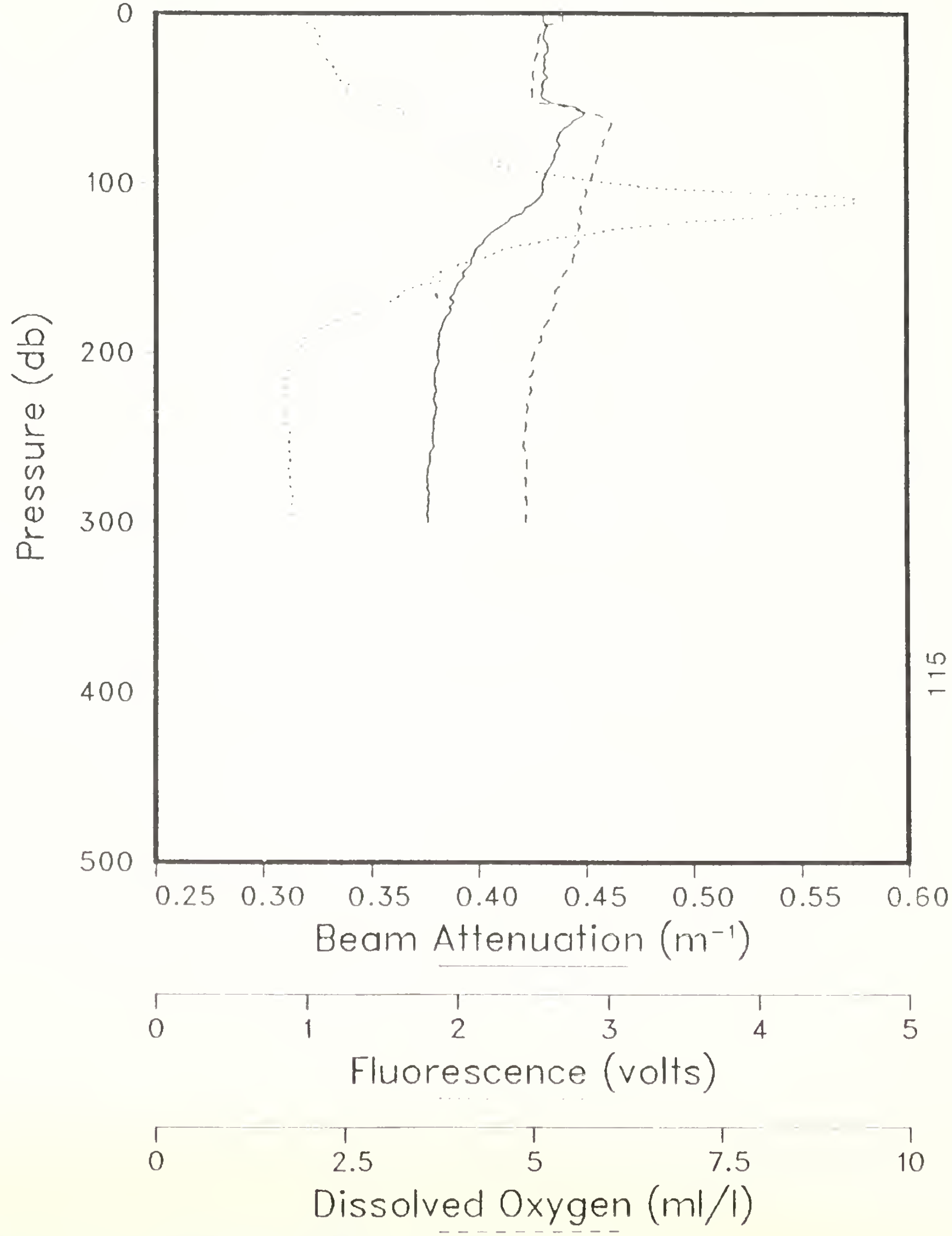




Latitude: 33.770°
Longitude: 141.454°

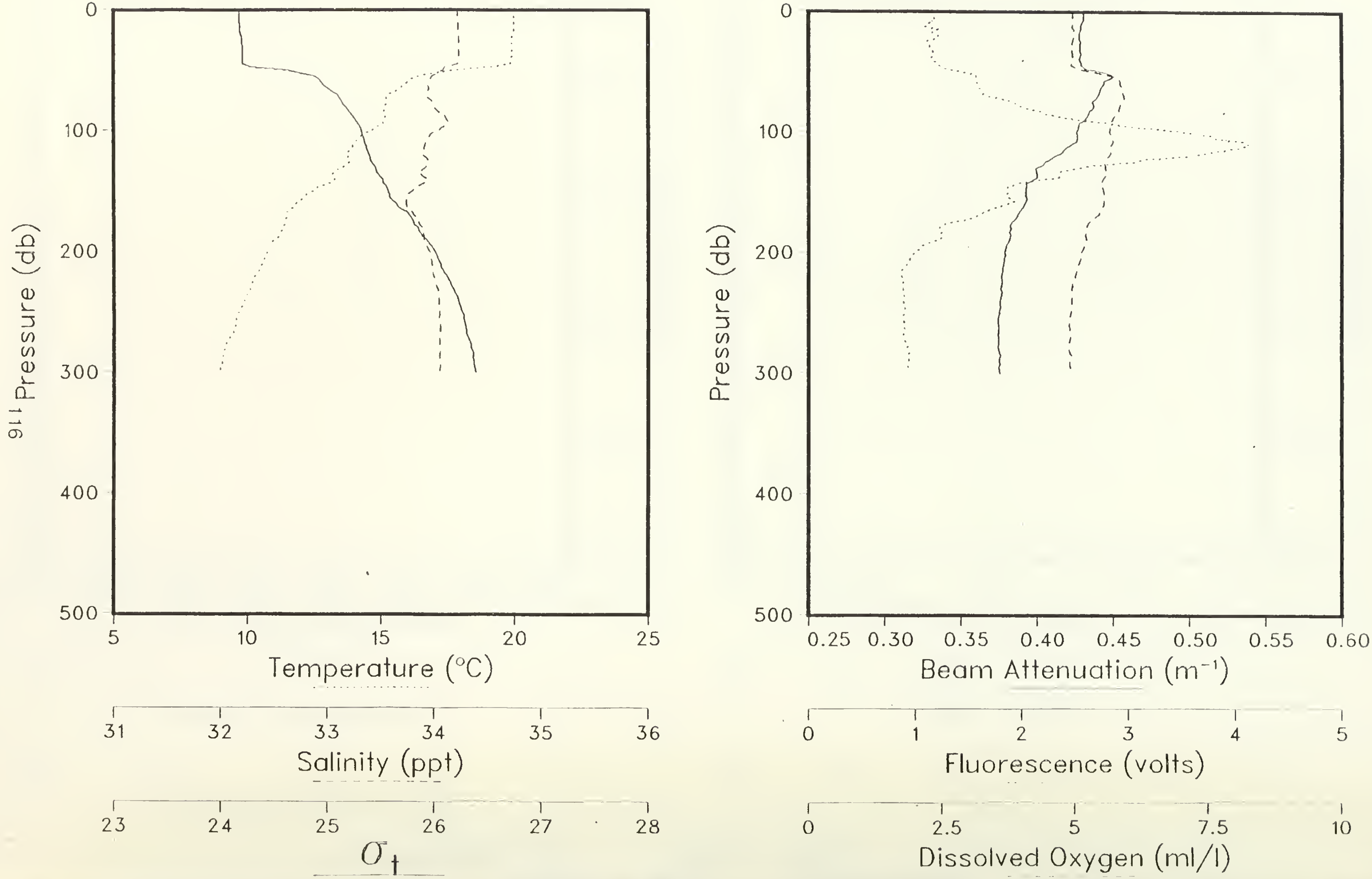
Date: 10/28/82
Time: 2002:12 GMT





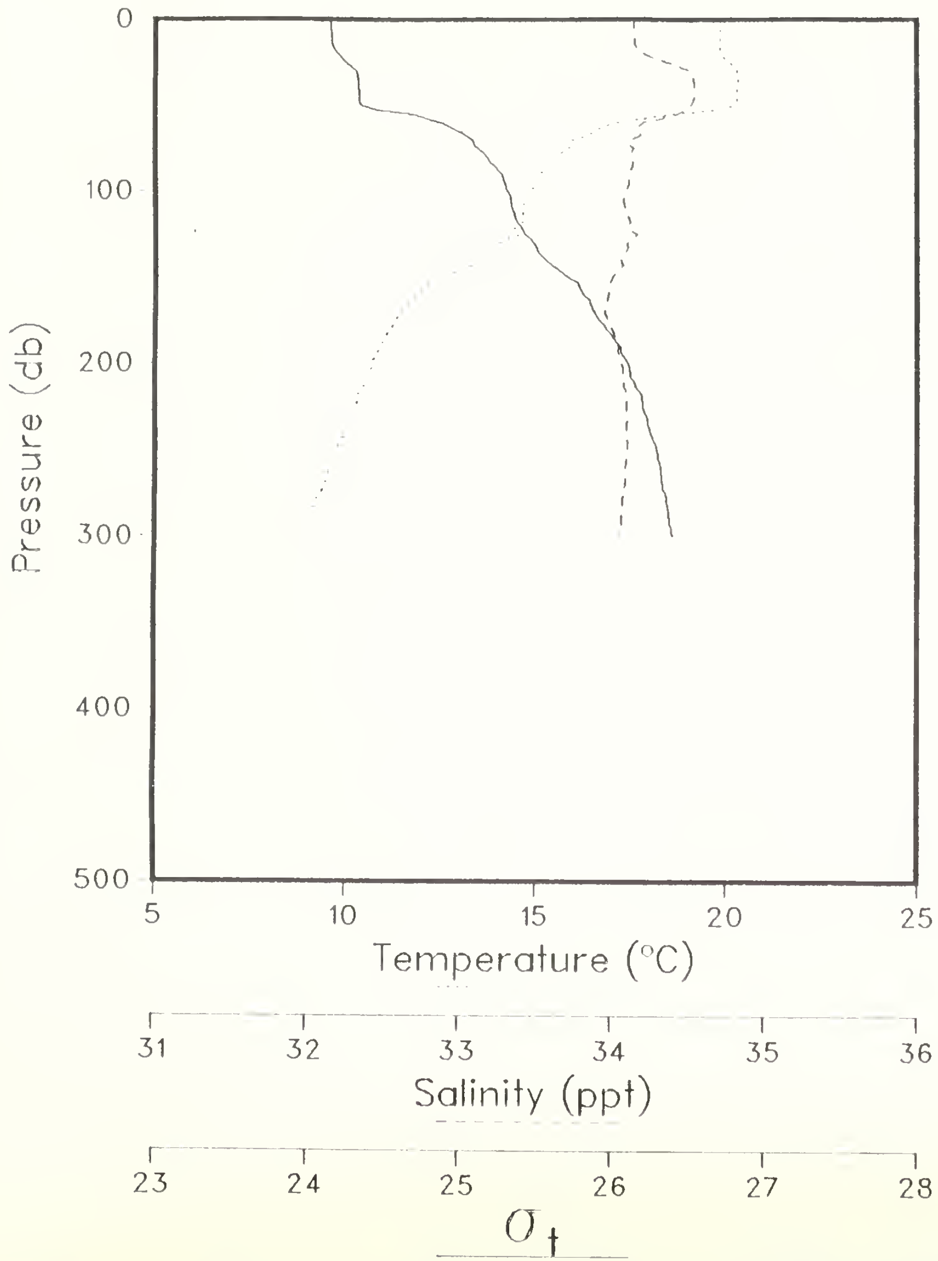
Latitude: 33.745°
Longitude: 141.293°

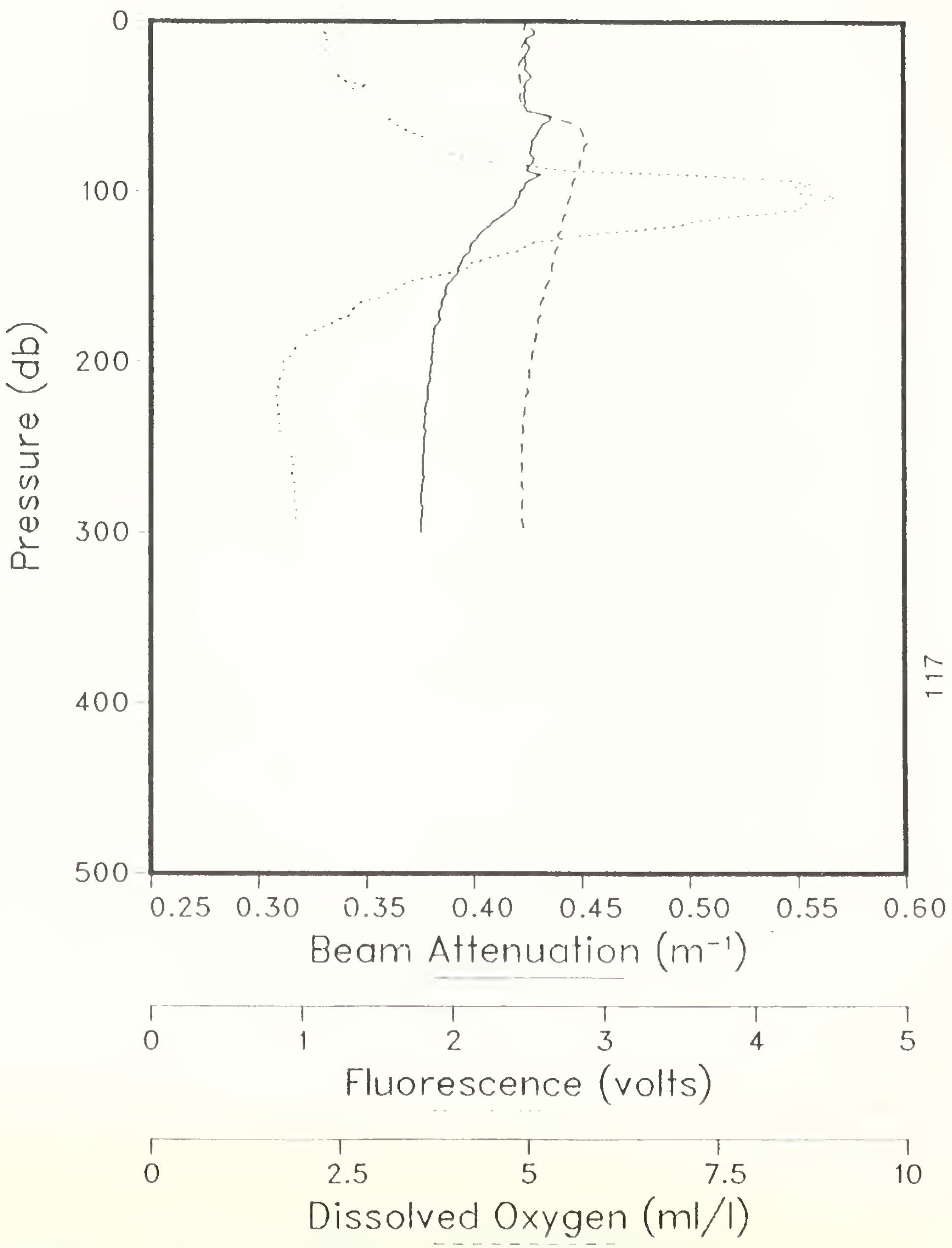
Date: 10/28/82
Time: 2303:47 GMT



Latitude: 33.728°

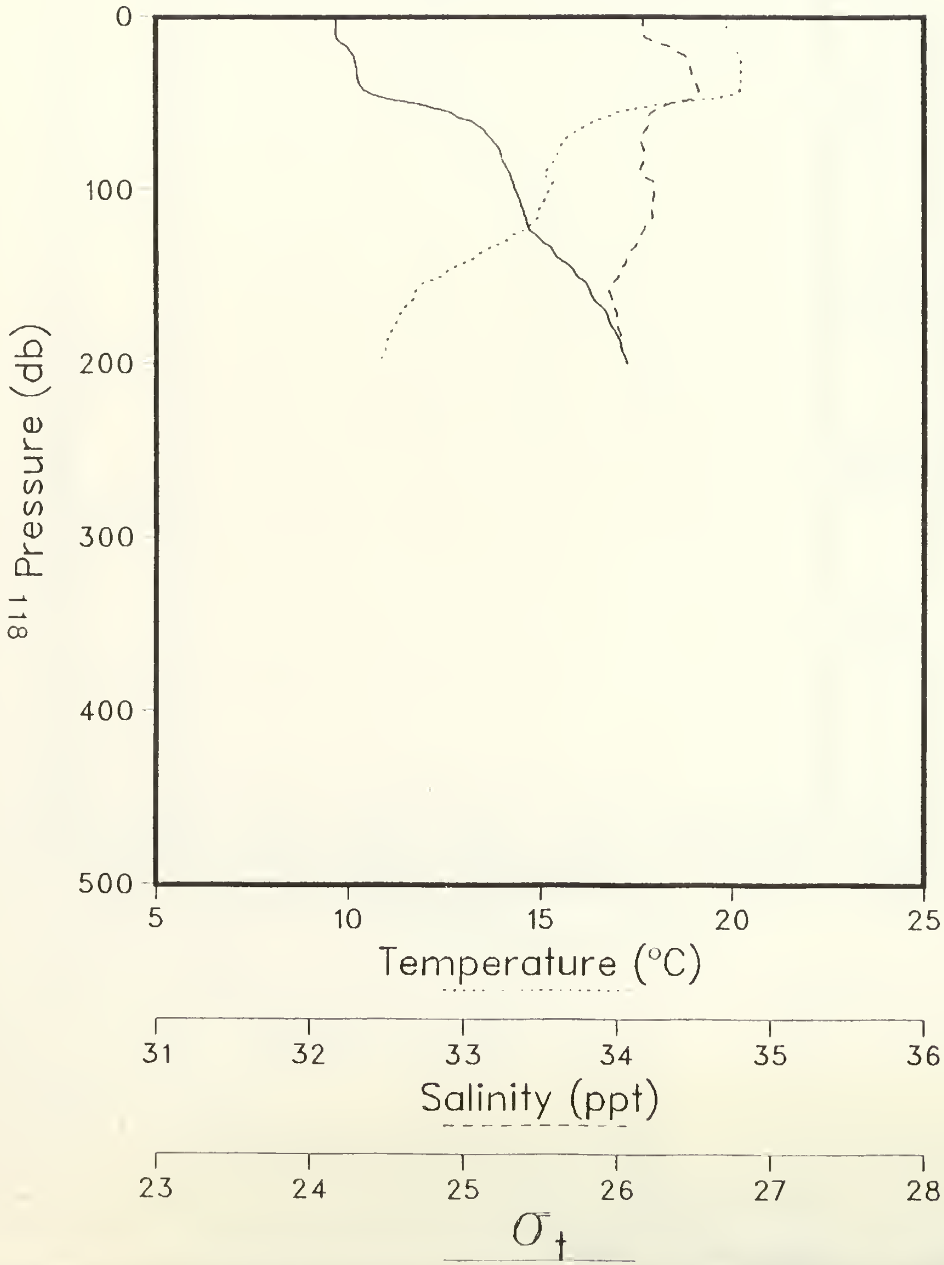
Date: 10/29/82

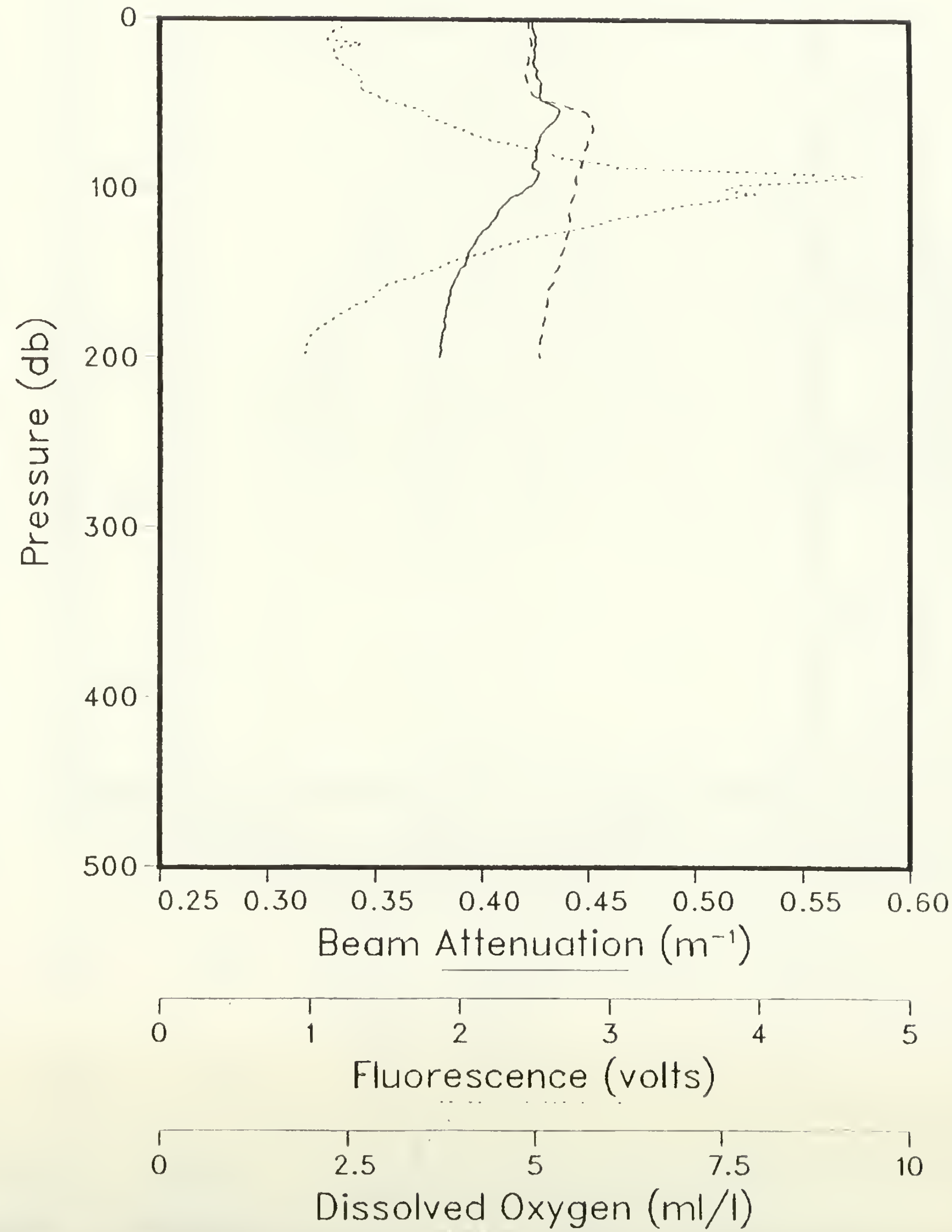




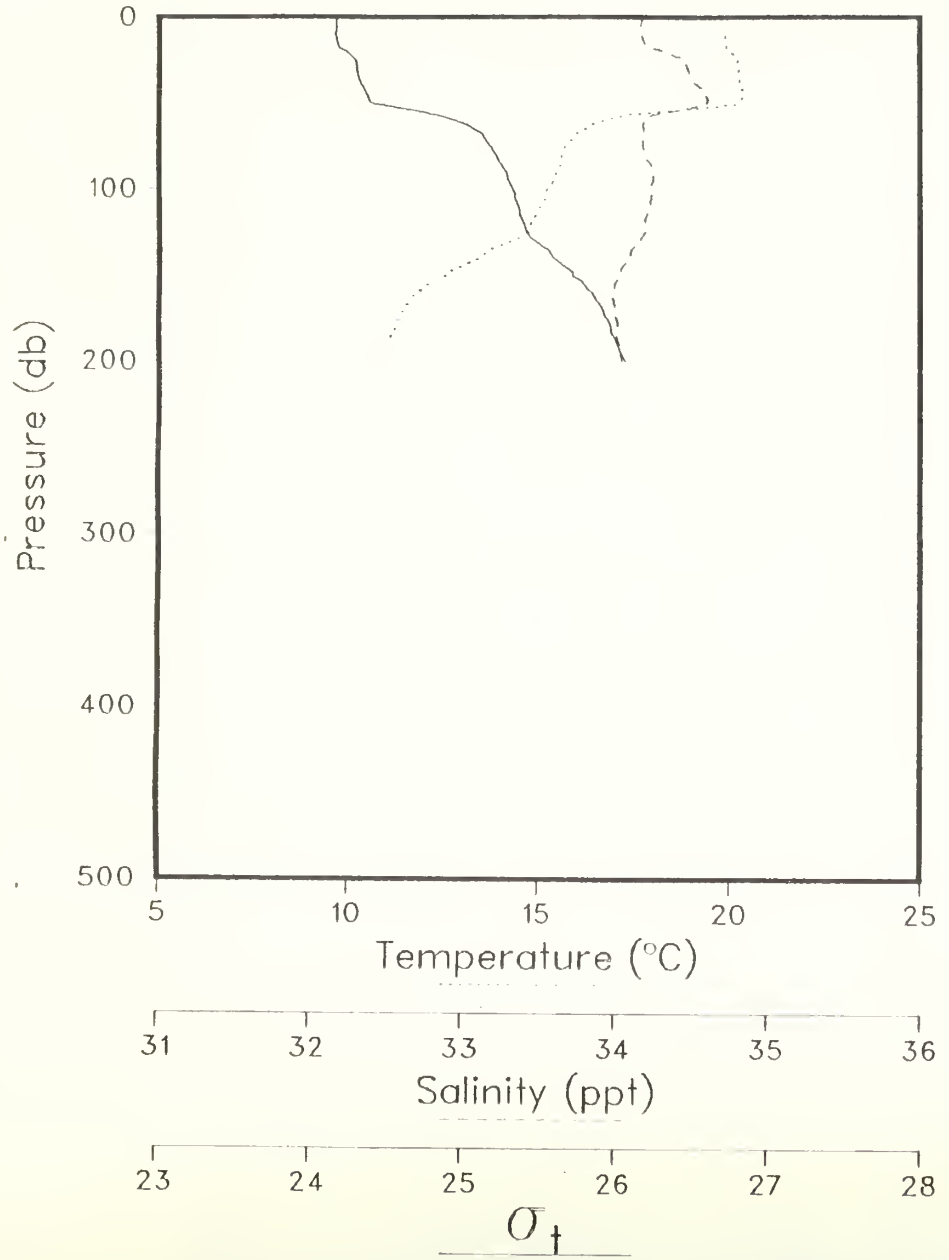
Latitude: 33.757°
Longitude: 140.993°

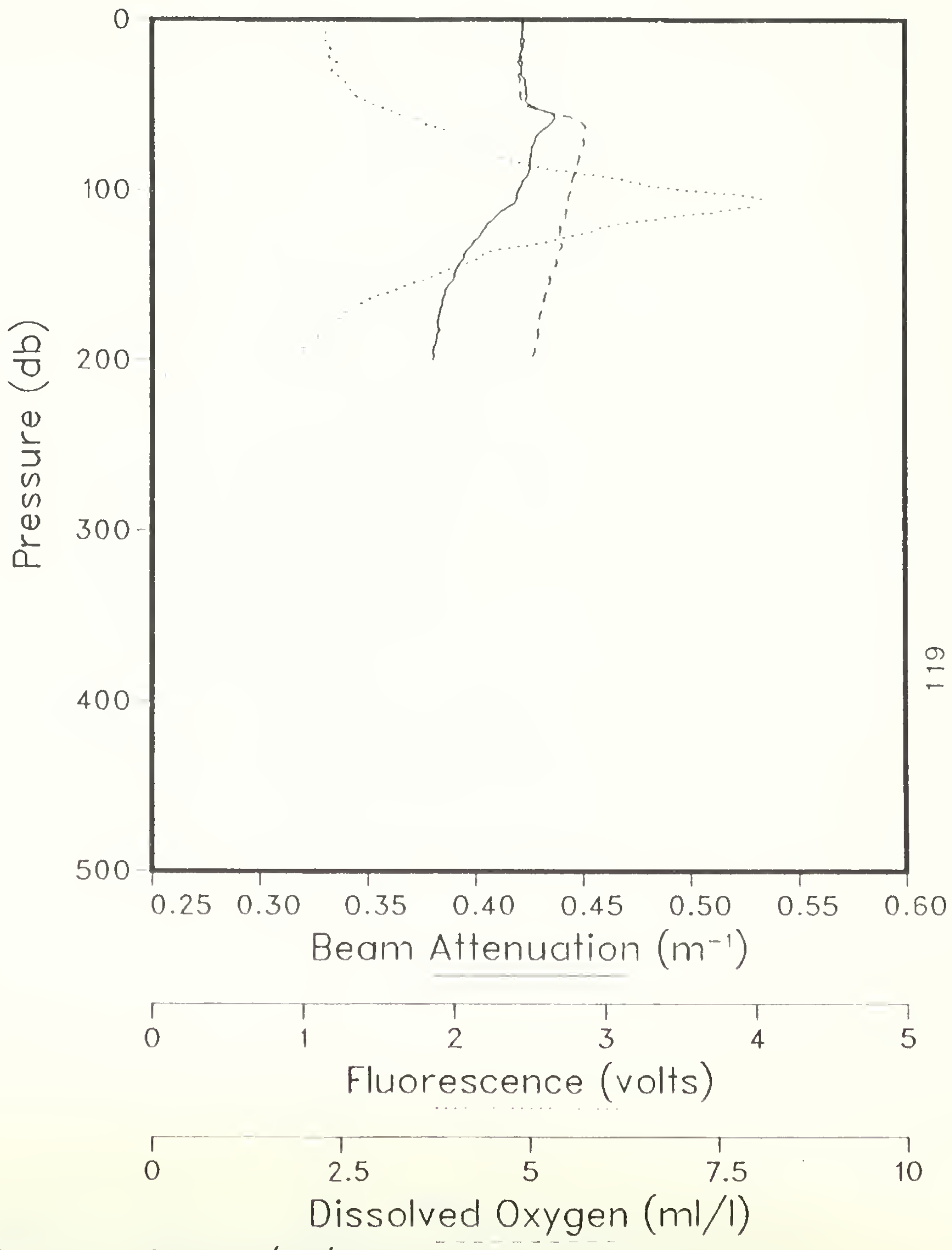
Date: 10/29/82
Time: 327:35 GMT





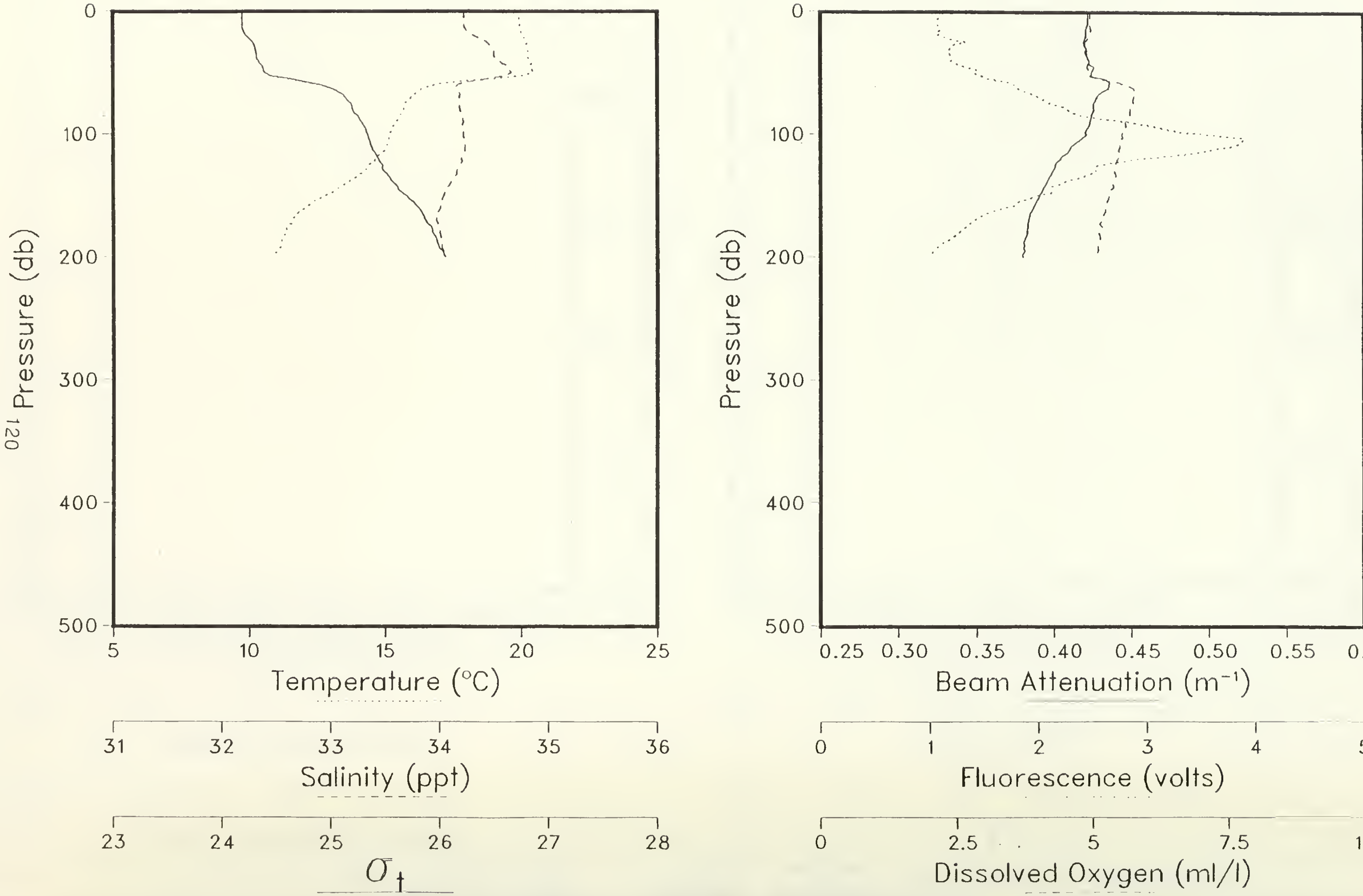
Latitude: 33.755° Date: 10/29/82





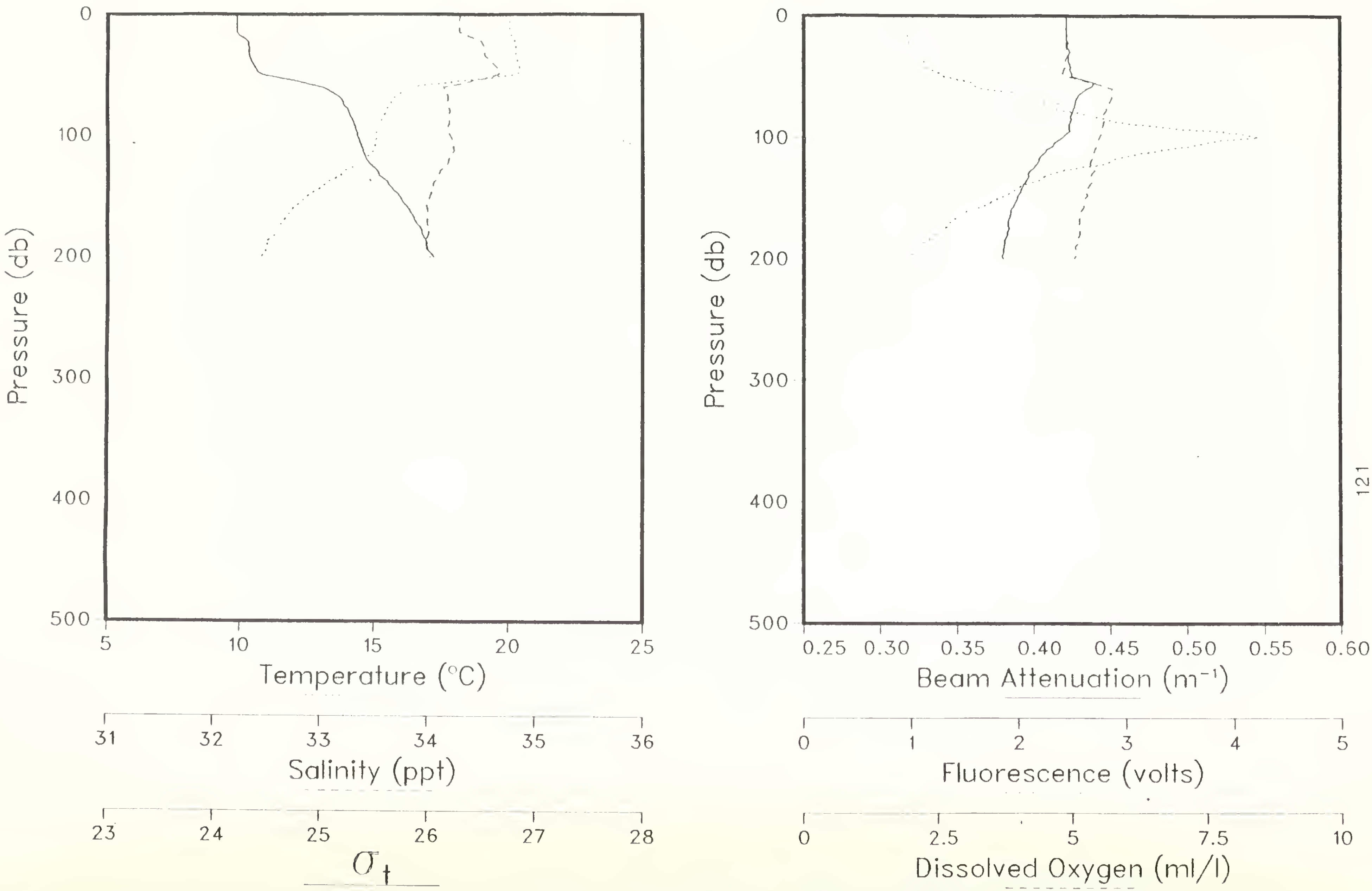
Latitude: 33.763°
Longitude: 140.967°

Date: 10/29/82
Time: 612:16 GMT



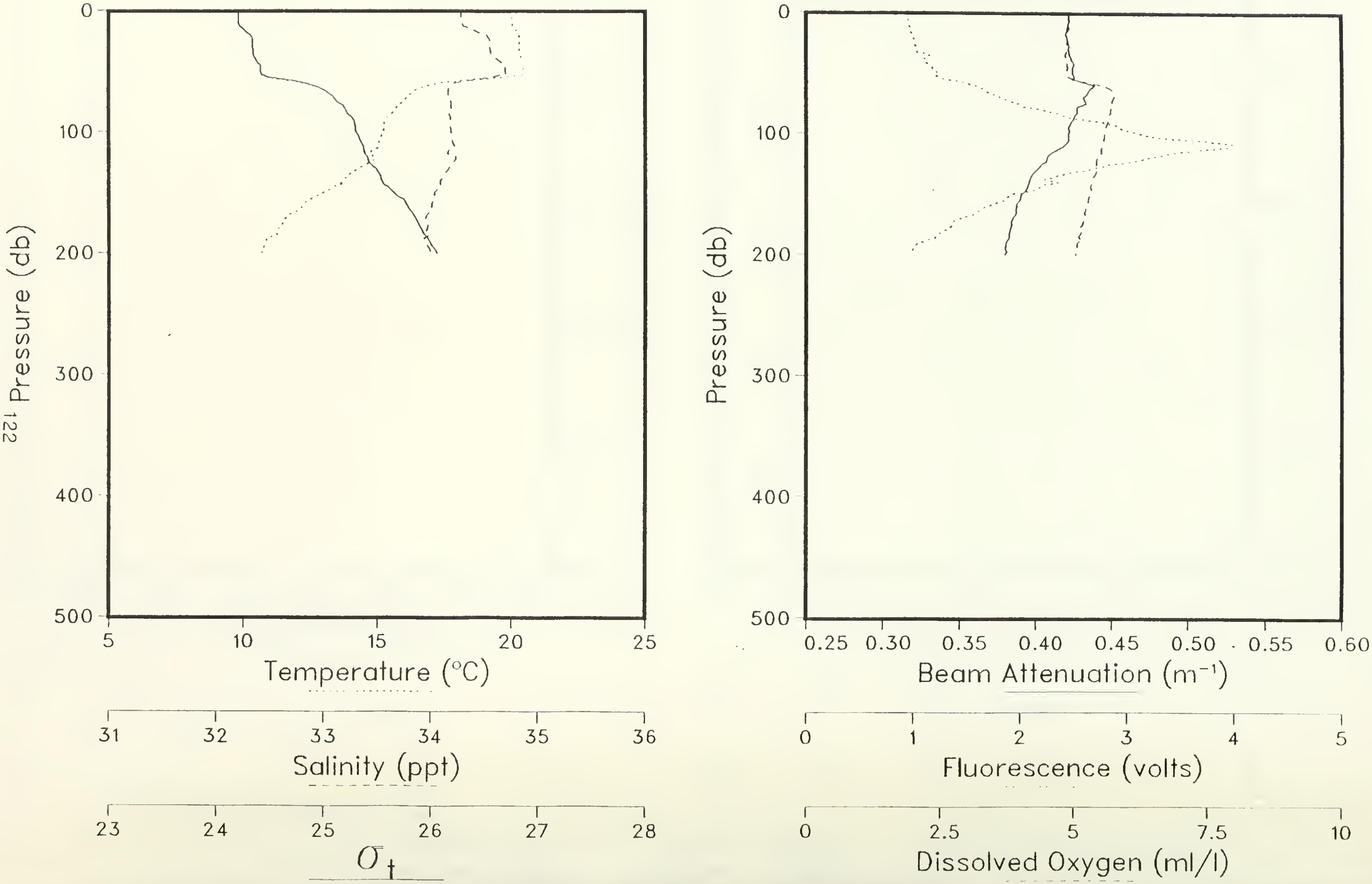
Latitude: 33.763°

Date: 10/29/82



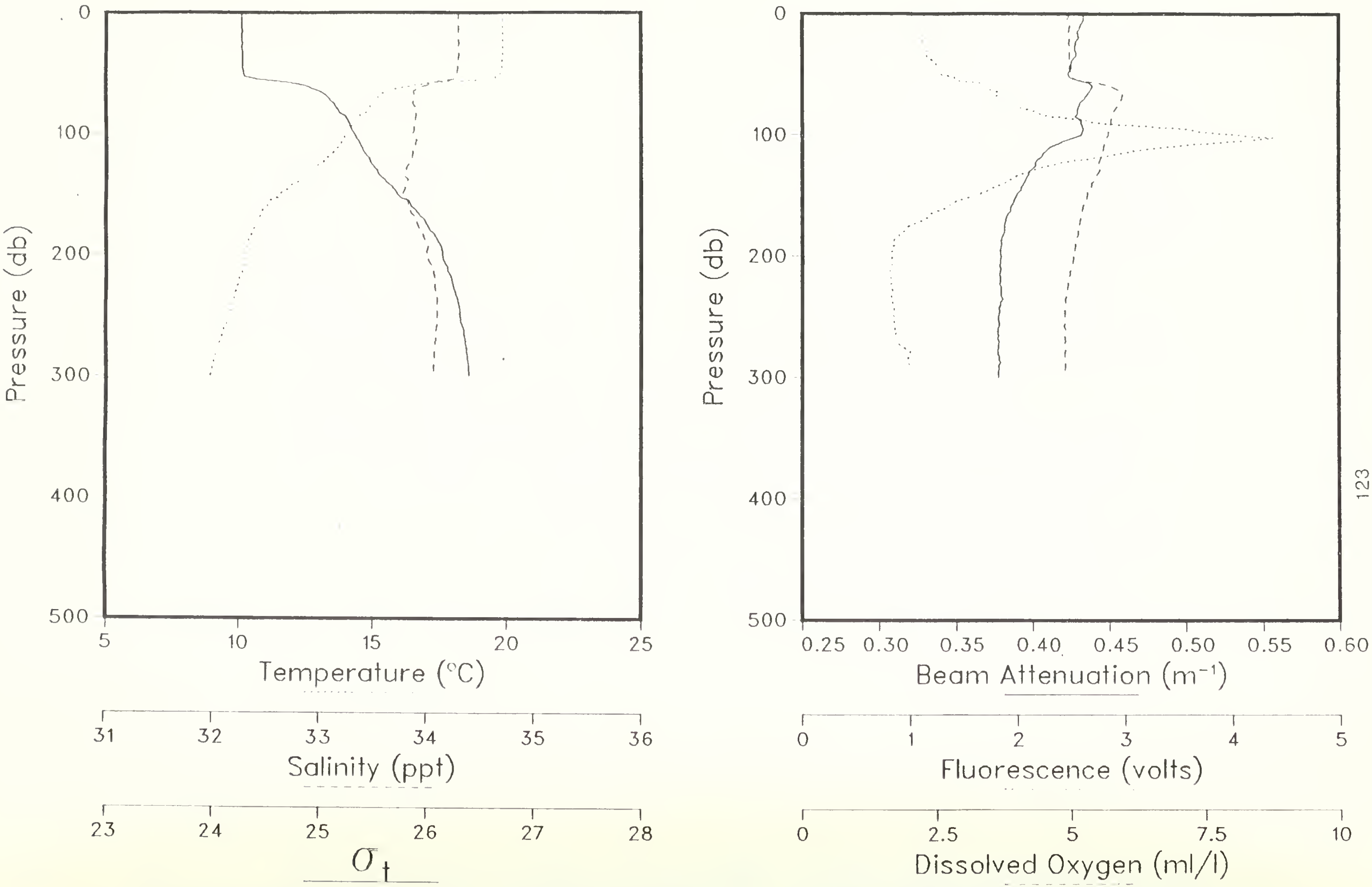
Latitude: 33.763°
Longitude: 140.967°

Date: 10/29/82
Time: 811:50 GMT



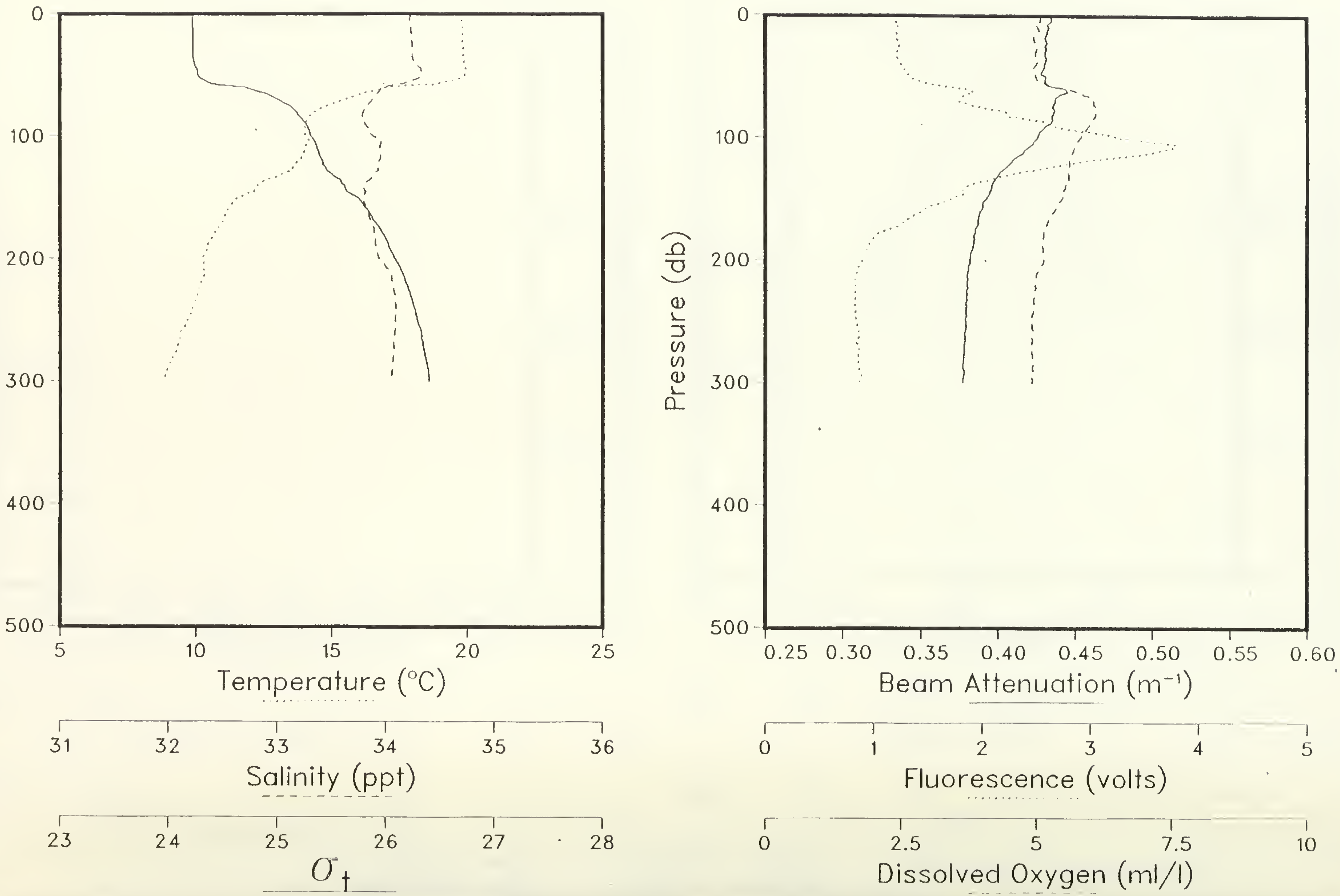
Latitude: 33.763°

Date: 10/29/82



Latitude: 33.557°
Longitude: 141.649°

Date: 10/29/82
Time: 2146:08 GMT



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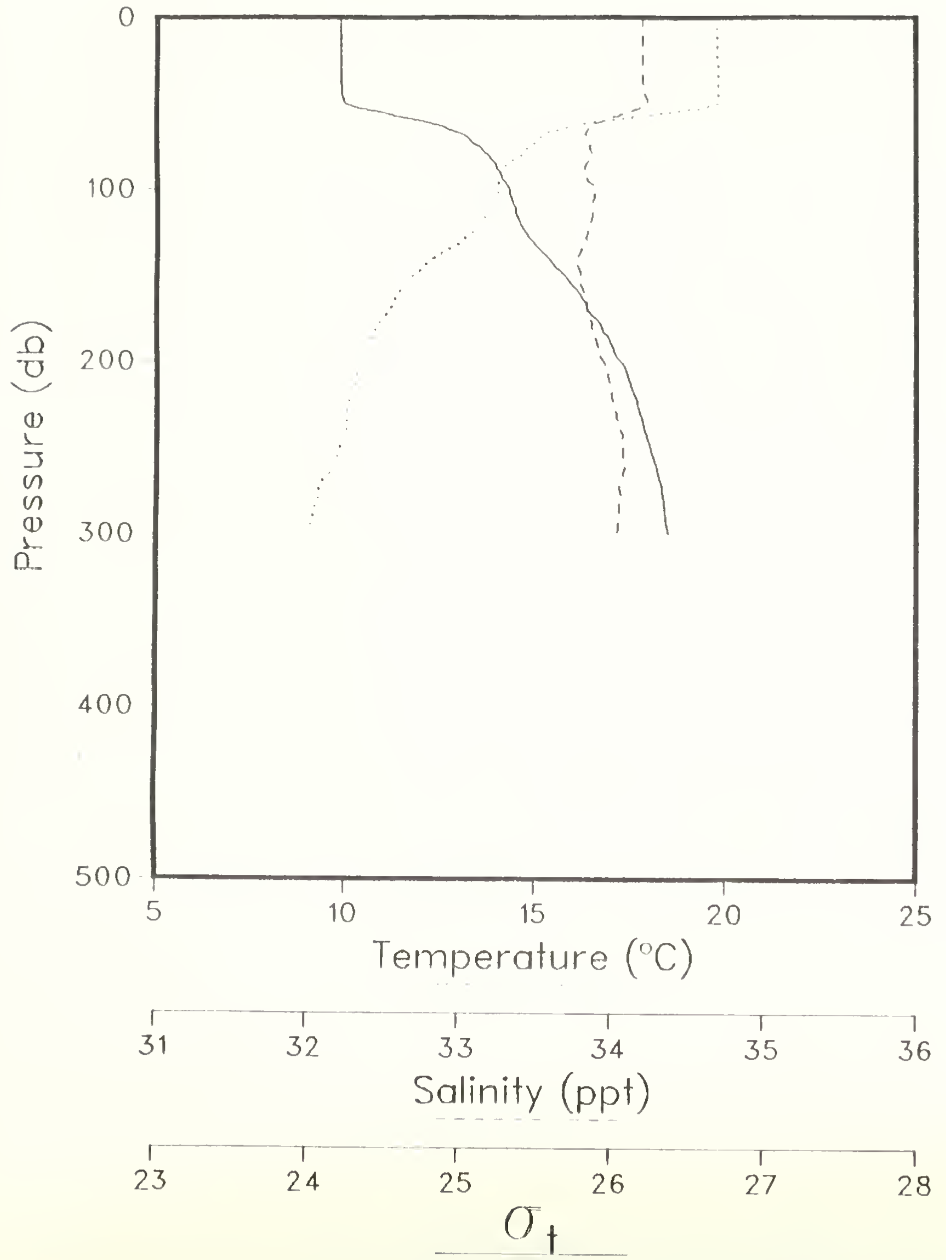
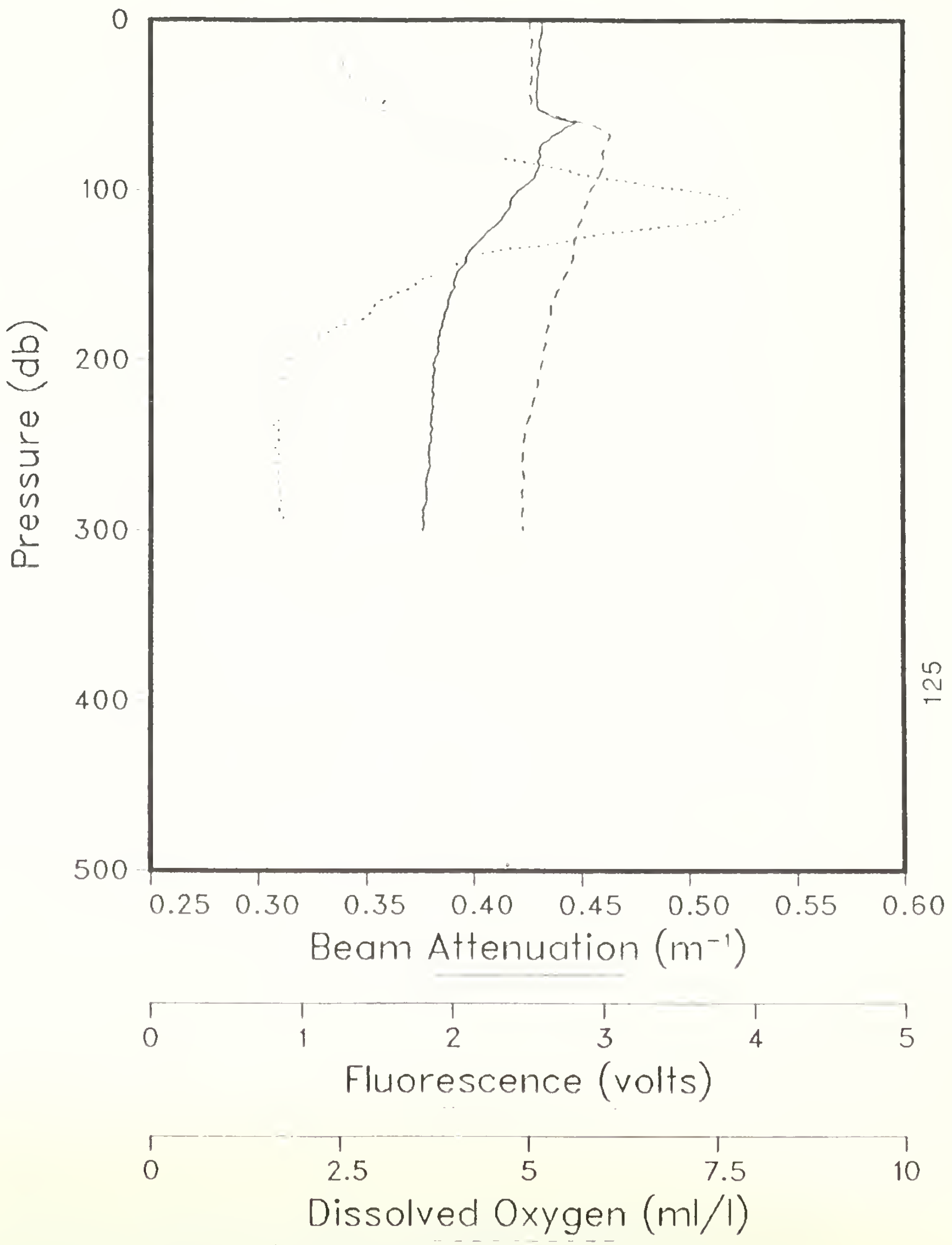
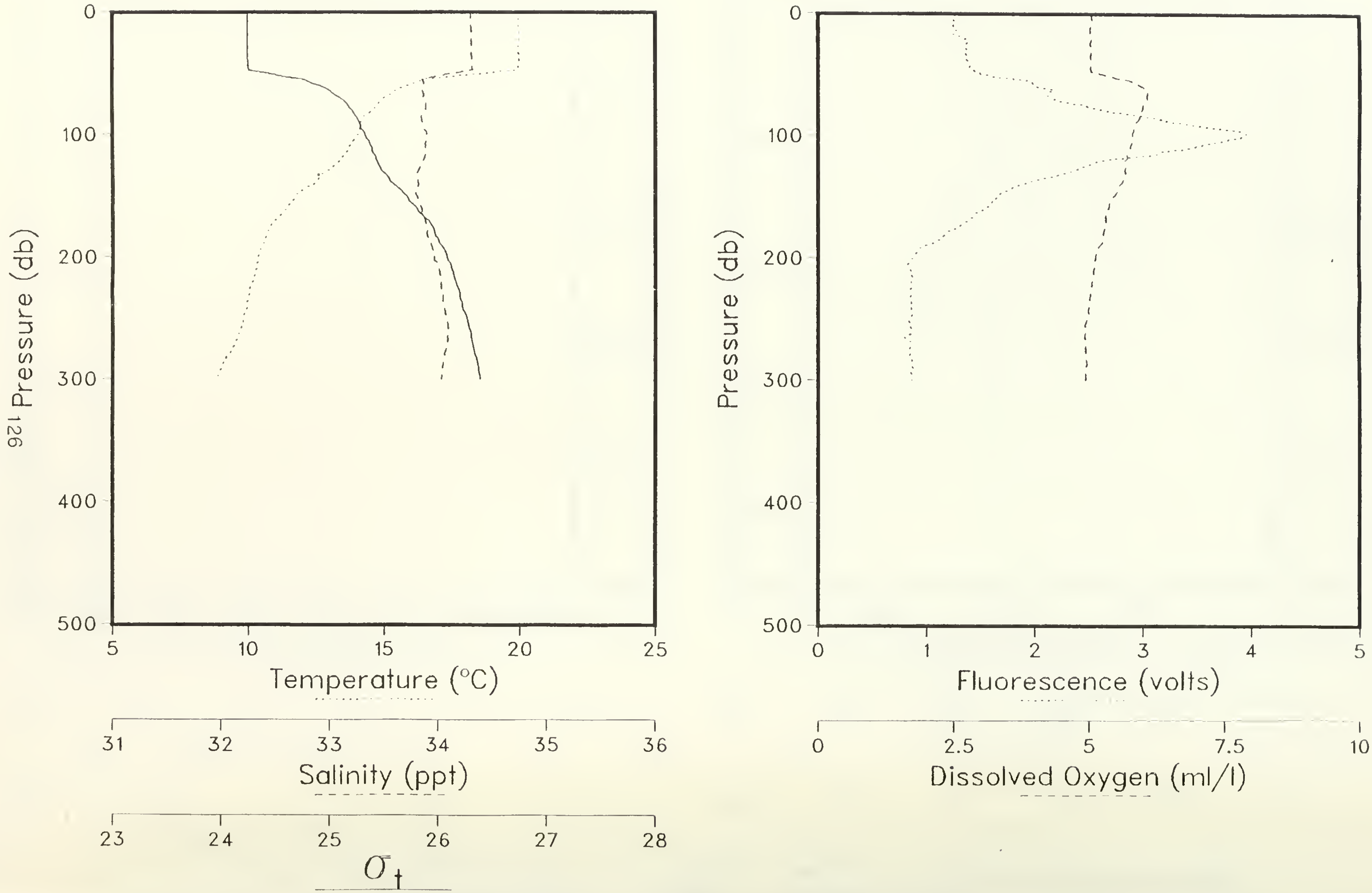
Latitude: 33.363° Date: 10/30/82





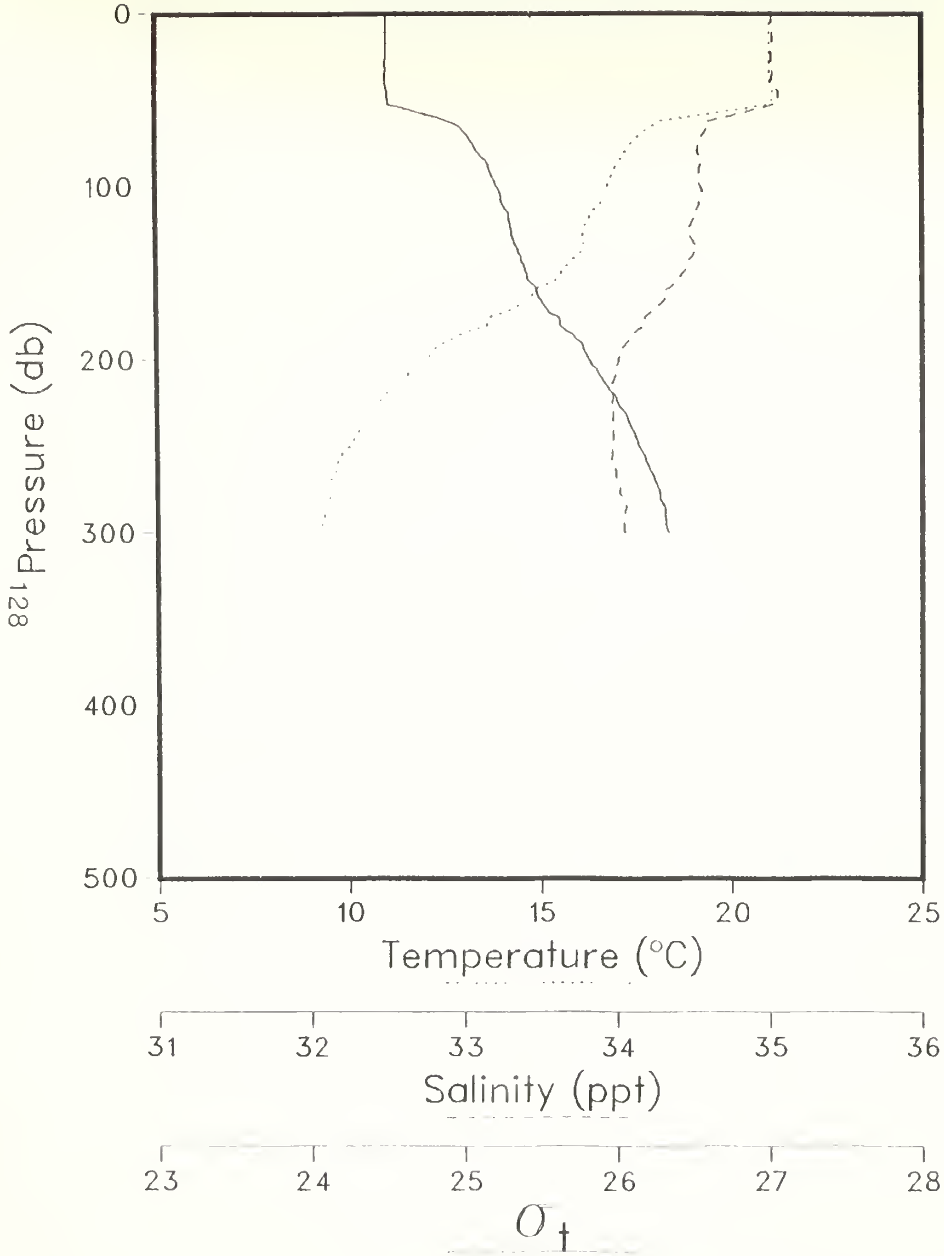
Latitude: 33.232°
Longitude: 141.653°

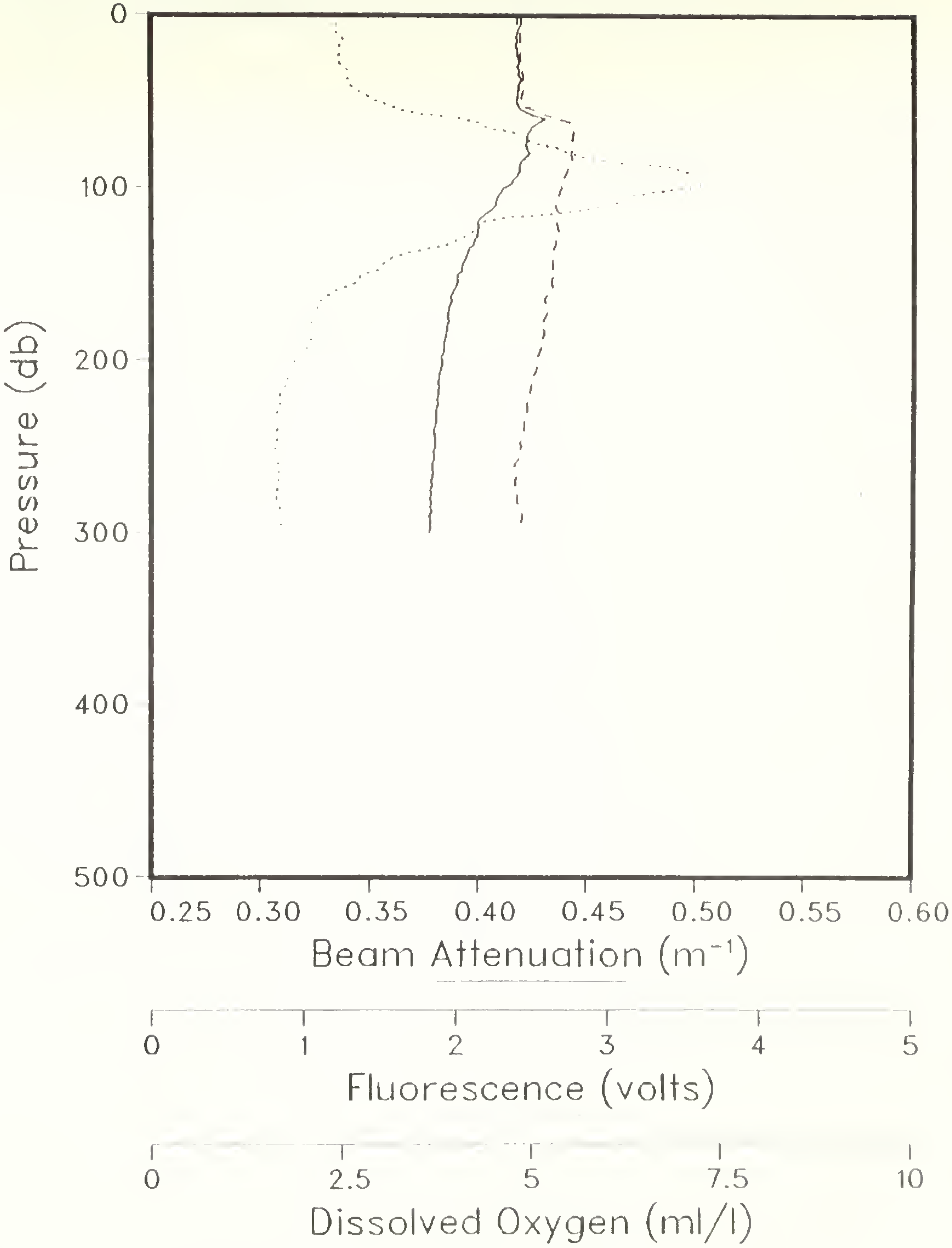
Date: 10/30/82
Time: 252:43 GMT



Latitude: 33.098°
Longitude: 141.718°

Date: 10/30/82
Time: 441:20 GMT

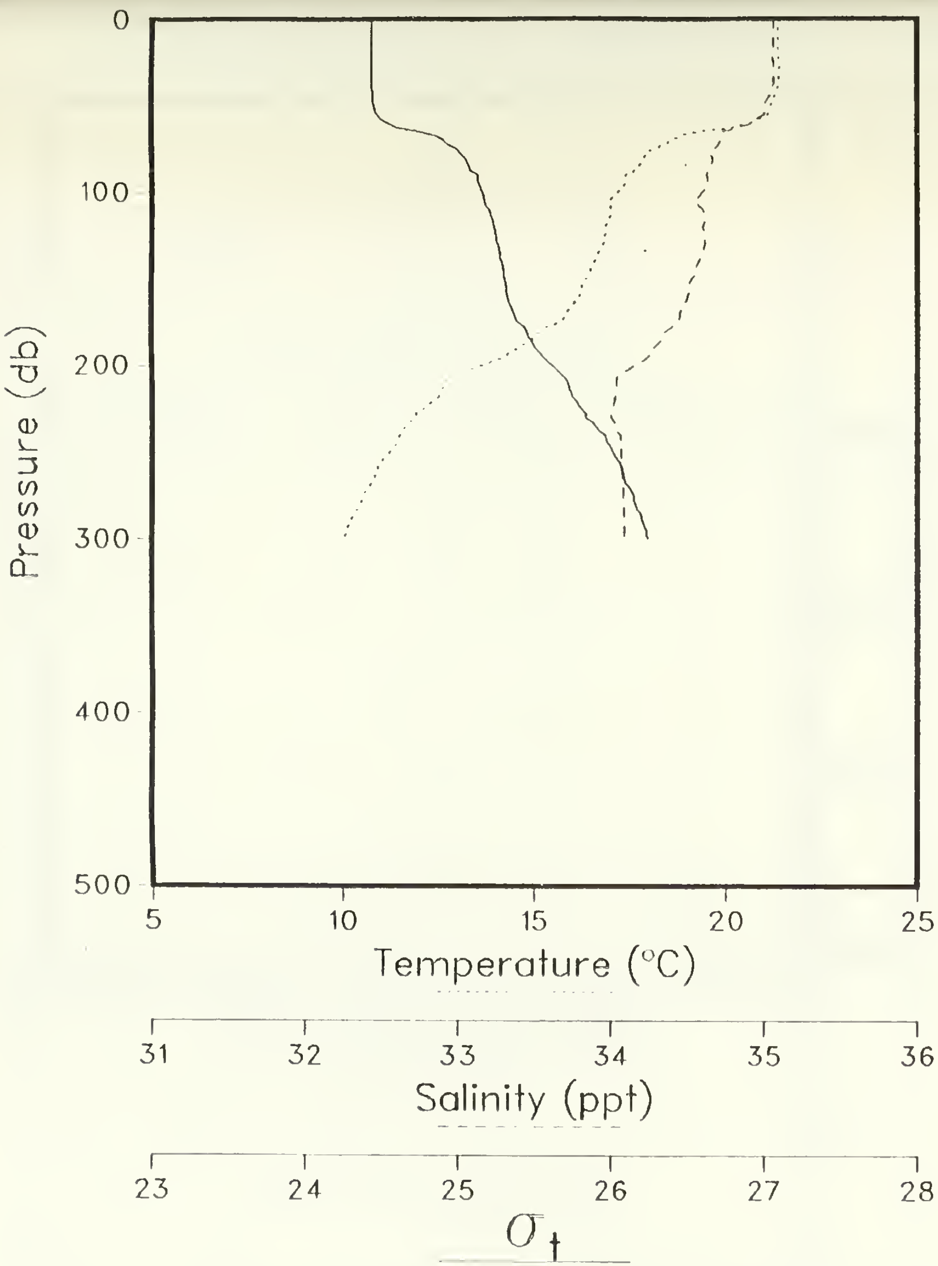


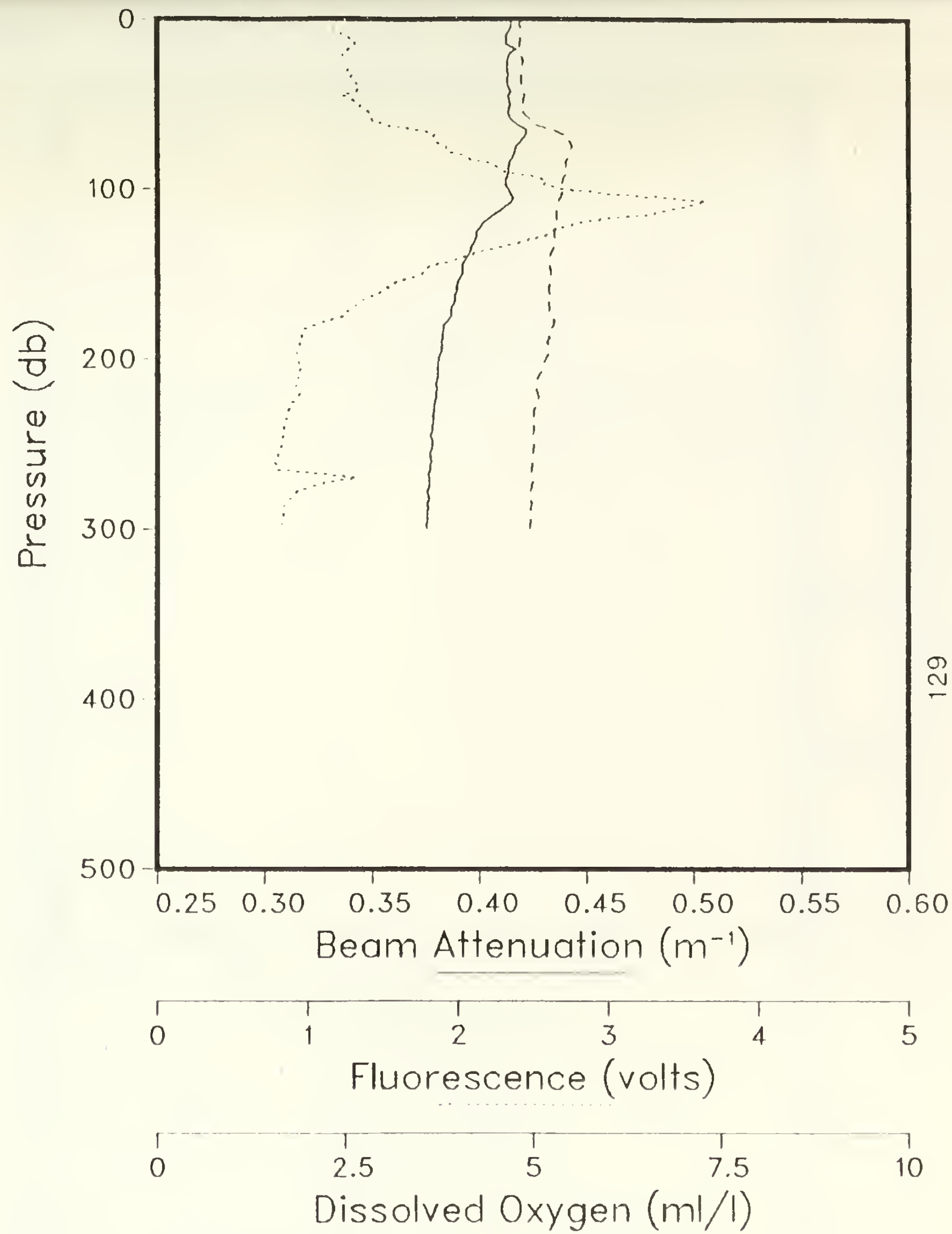


Latitude: 32.558°
Longitude: 141.648°

Date: 10/30/82
Time: 1110:26 GMT

R/V ACANIA CRUISE ODEX3 STATION 71

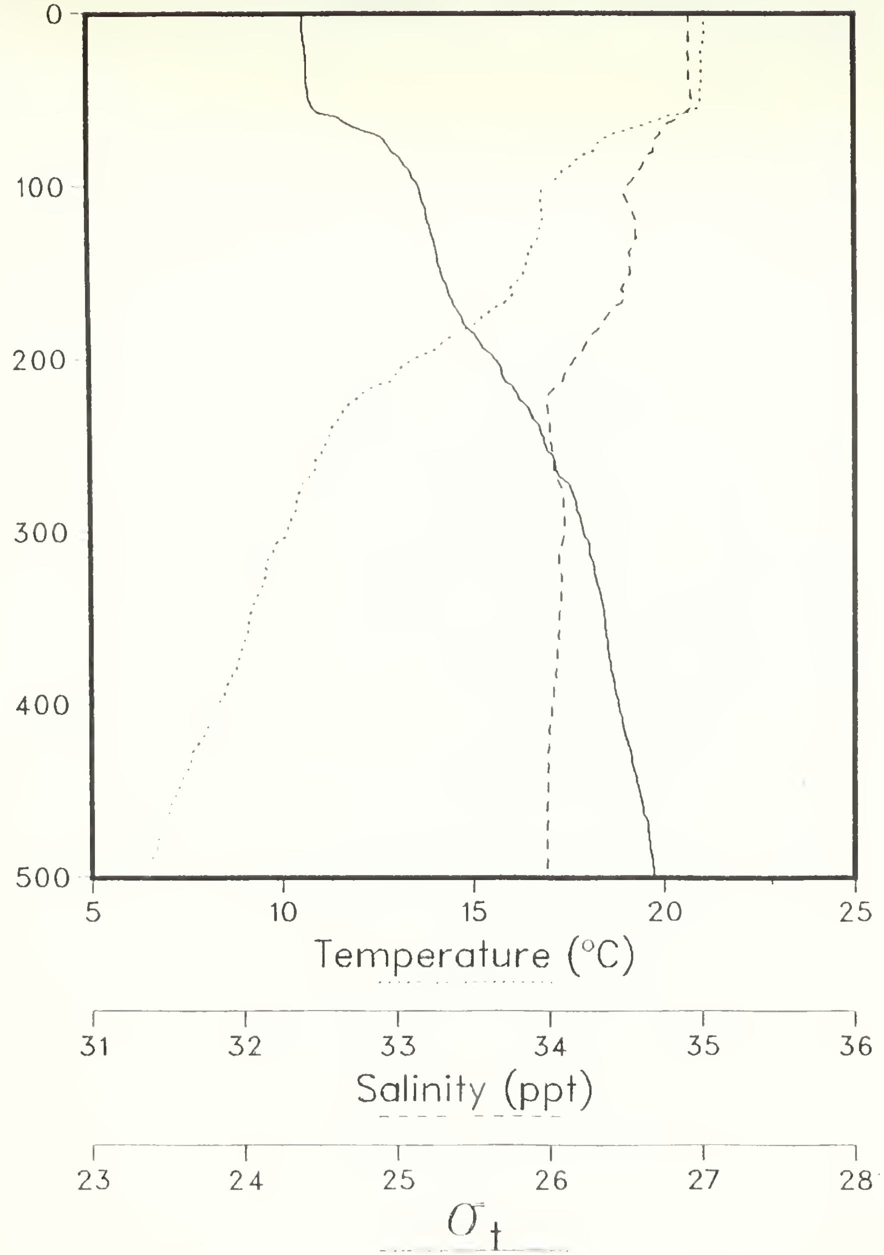


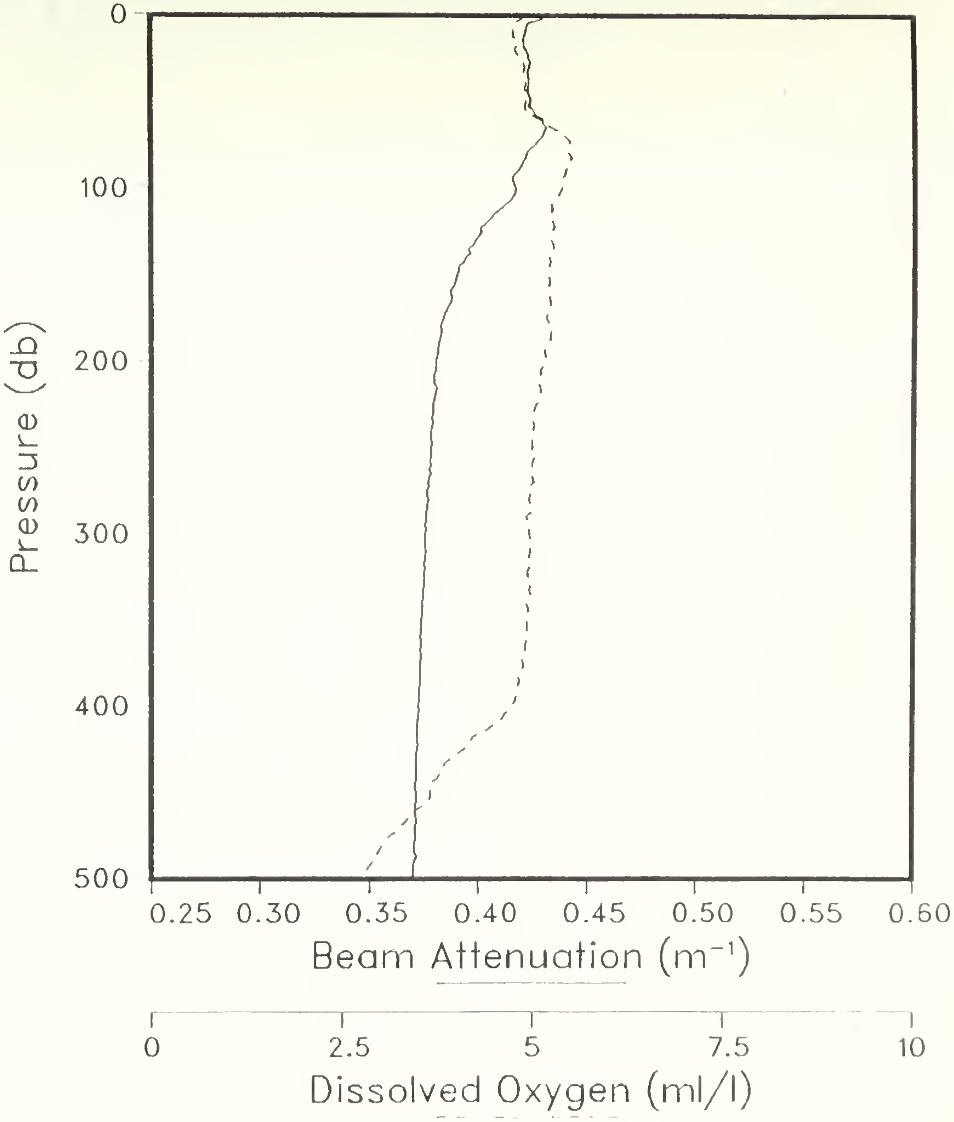


Latitude: 31.408°
Longitude: 141.586°

Date: 10/31/82
Time: 1734:07 GMT

R/V ACANIA CRUISE ODEX3 STATION 72

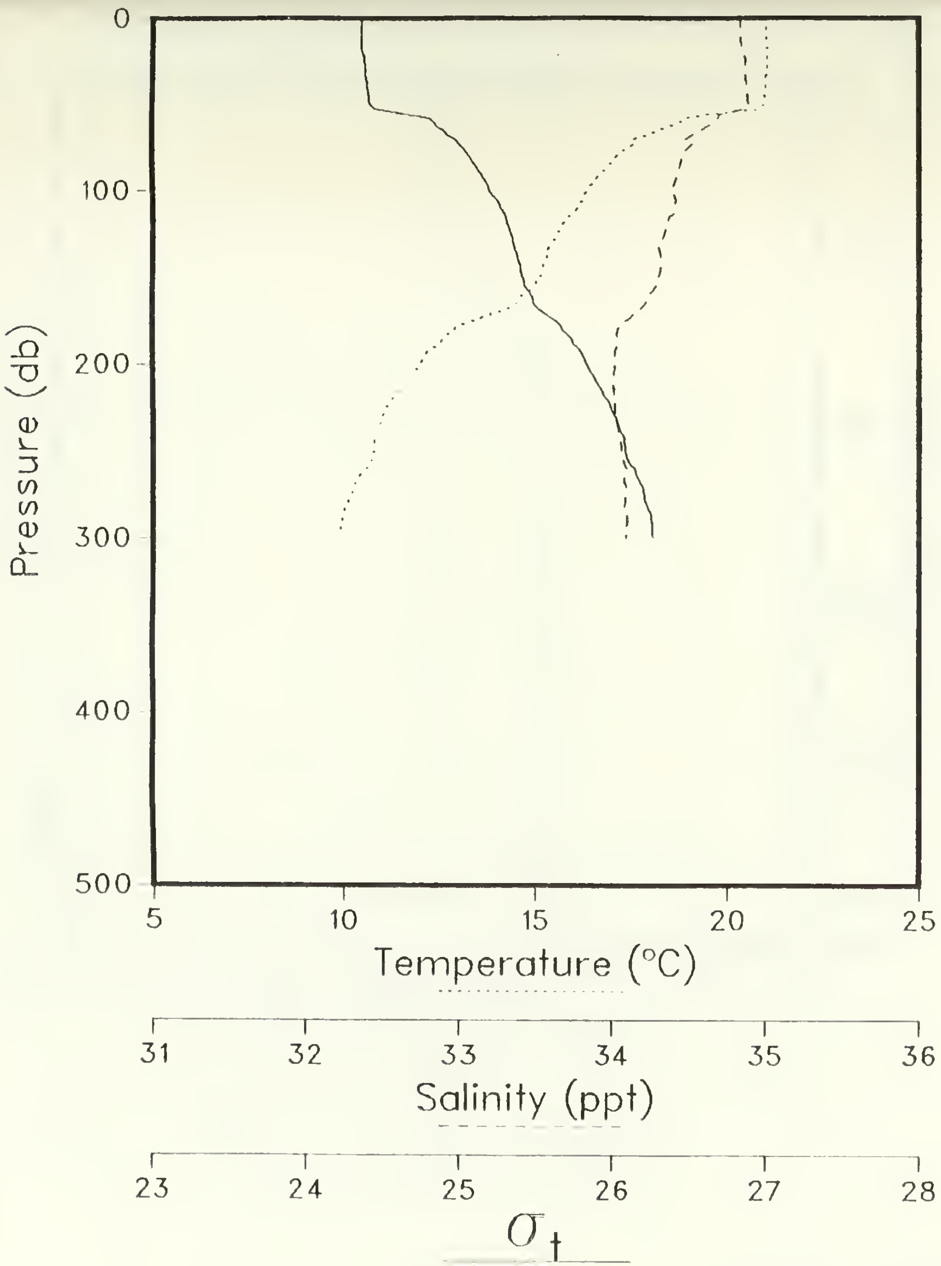


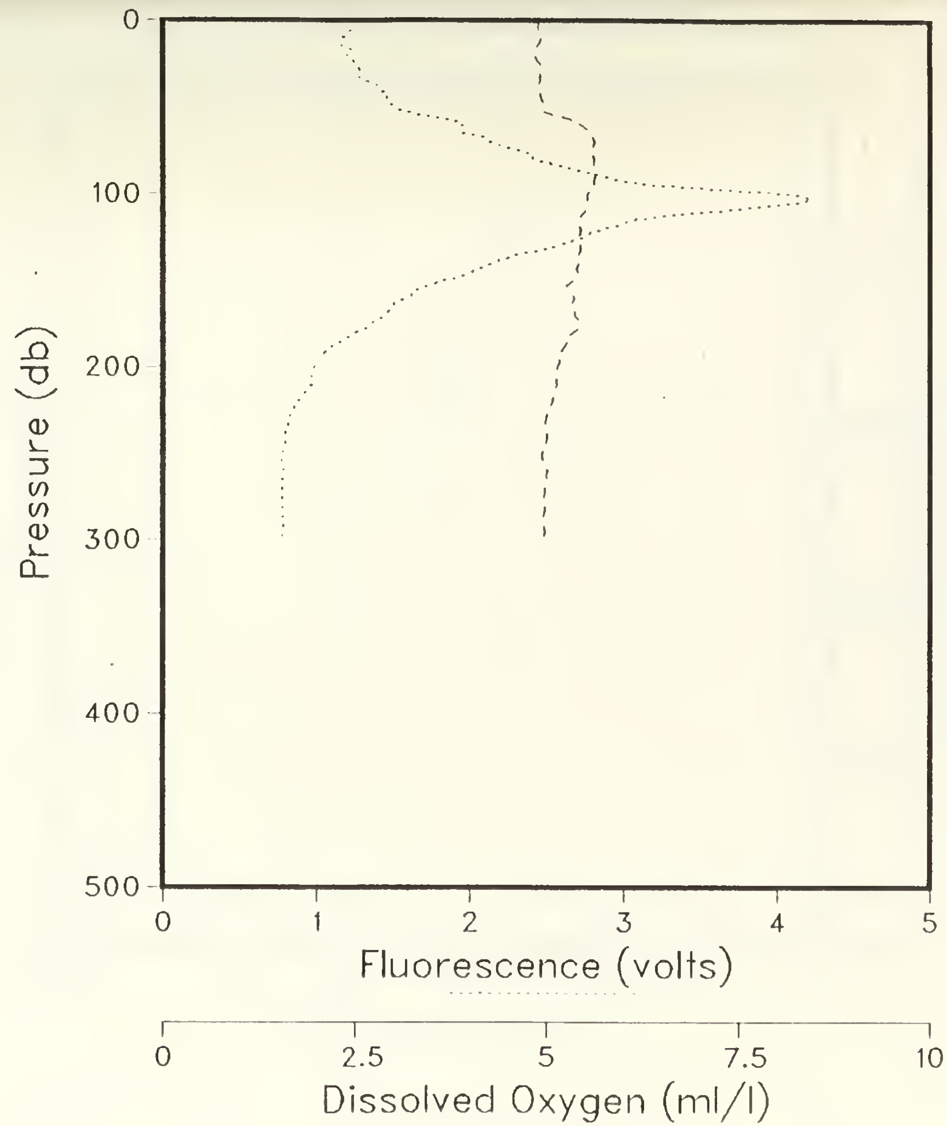


Latitude: 31.043°
Longitude: 141.582°

Date: 11/1/82
Time: 30:06 GMT

R/V ACANIA CRUISE ODEX3 STATION 73

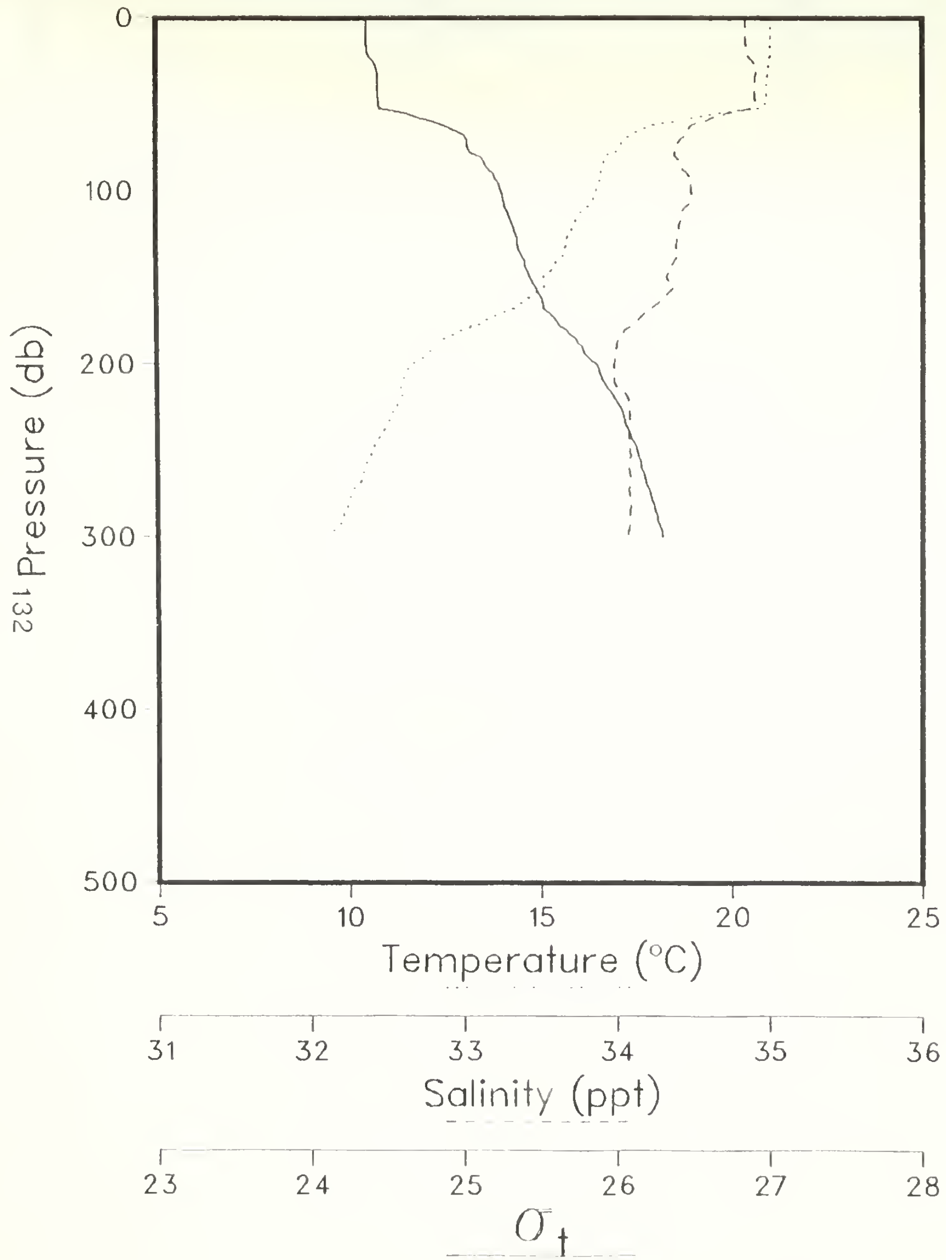


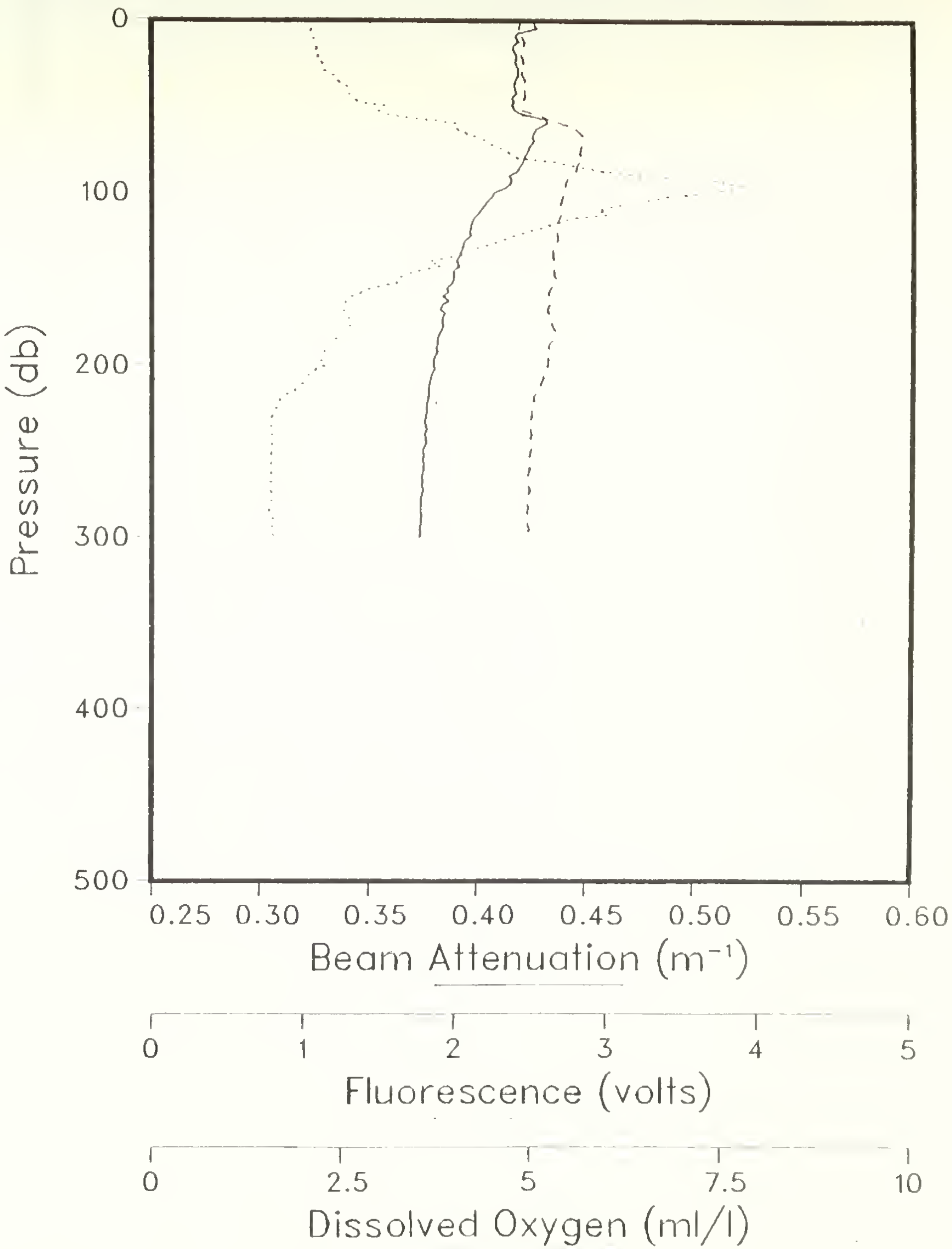


Latitude: 30.906°
Longitude: 141.419°

Date: 11/1/82
Time: 507:46 GMT

R/V ACANIA CRUISE ODEX3 STATION 74

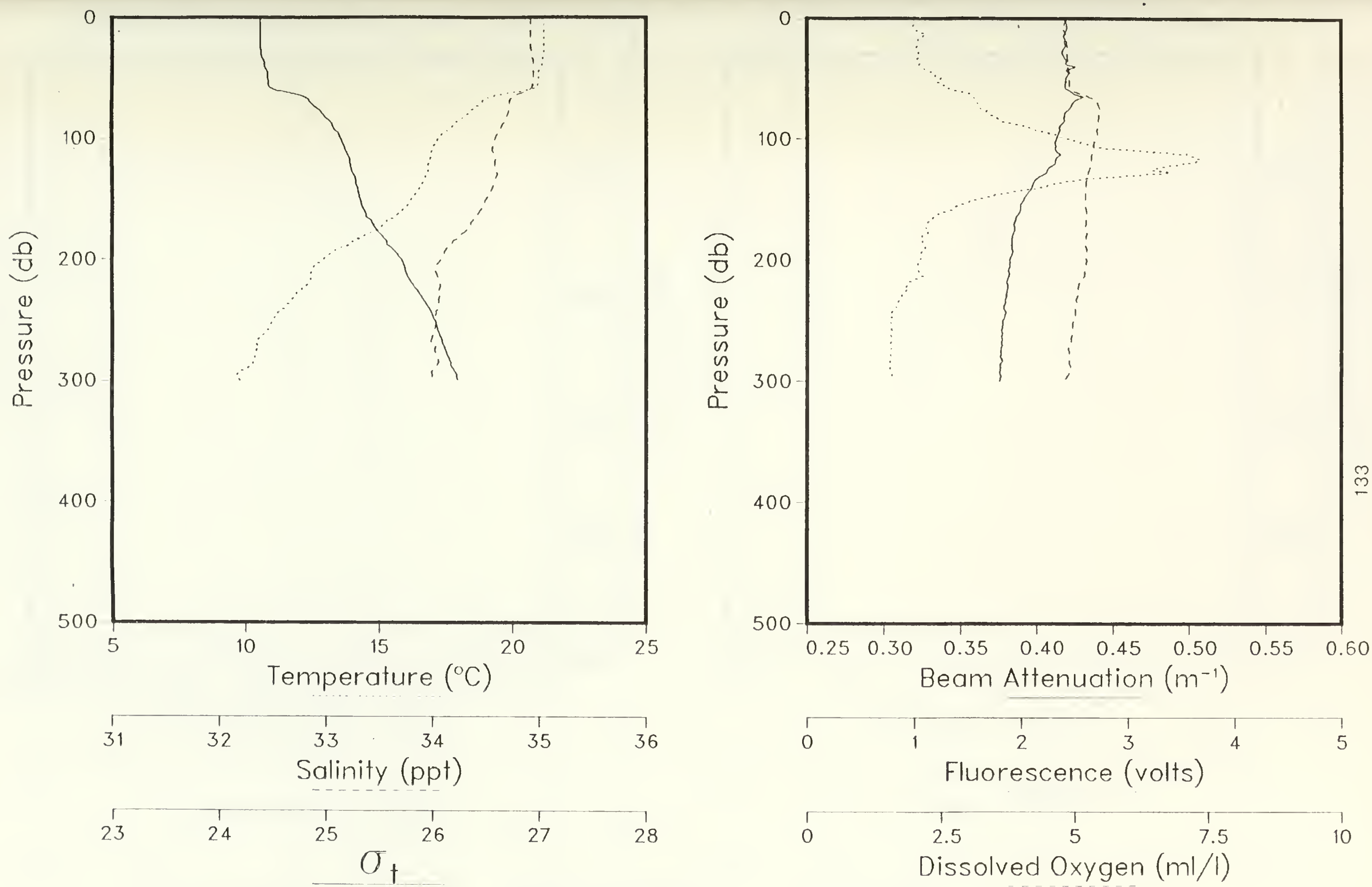




Latitude: 30.333°
Longitude: 141.467°

Date: 11/1/82
Time: 1108:03 GMT

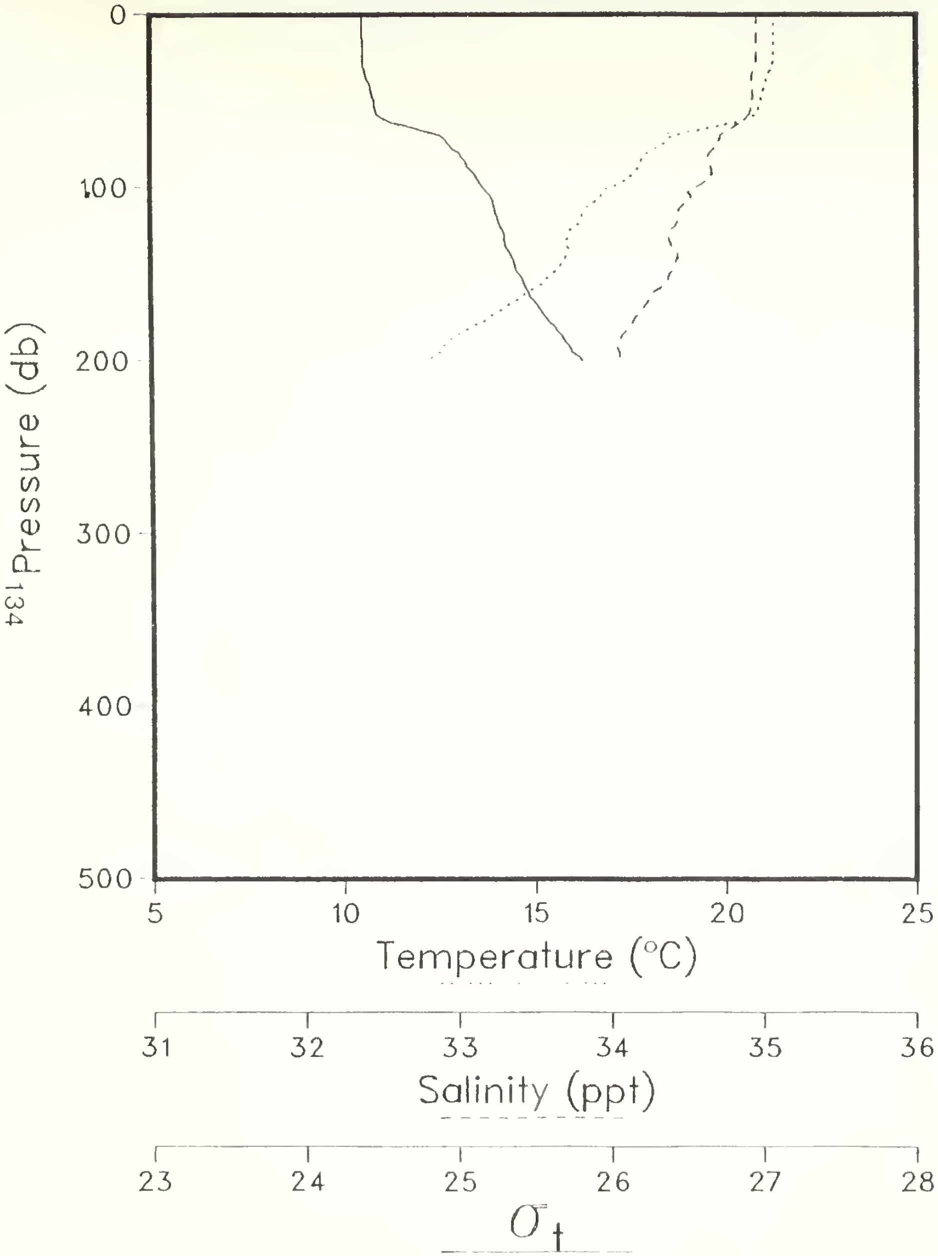
R/V ACANIA CRUISE ODEX3 STATION 75

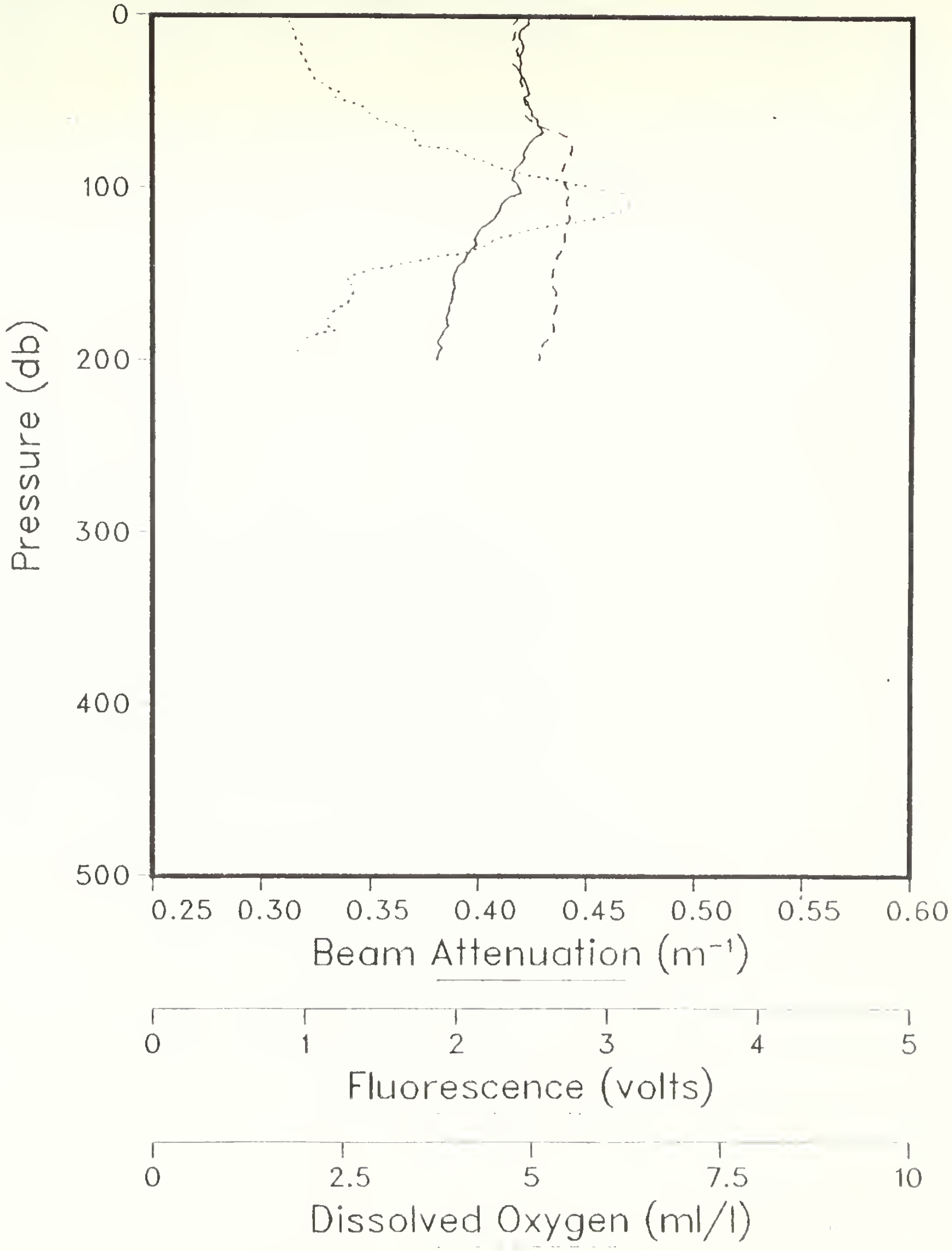


Latitude: 30.009°
Longitude: 141.501°

Date: 11/1/82
Time: 16:36:14 GMT

R/V ACANIA CRUISE ODEX3 STATION 76

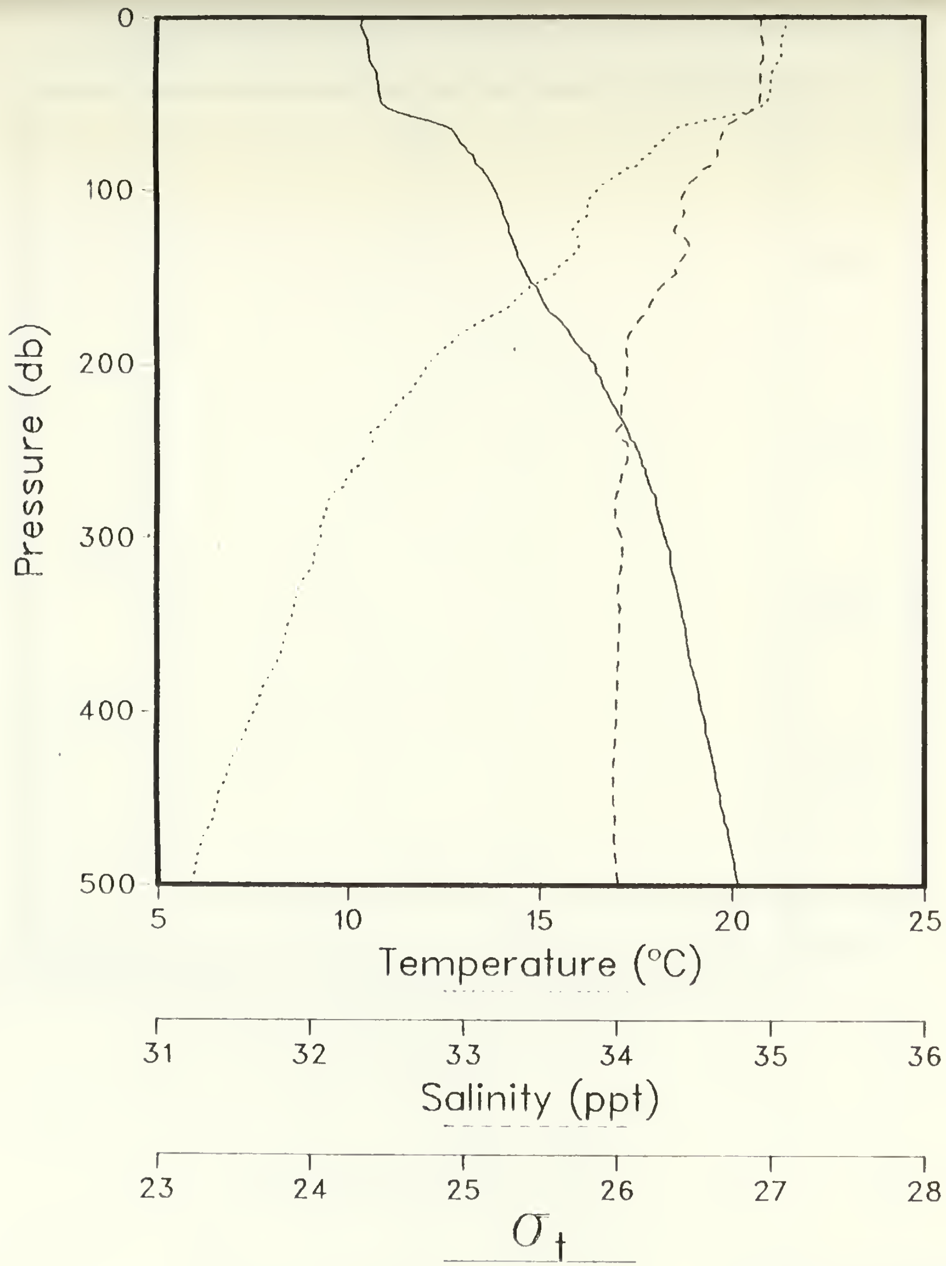


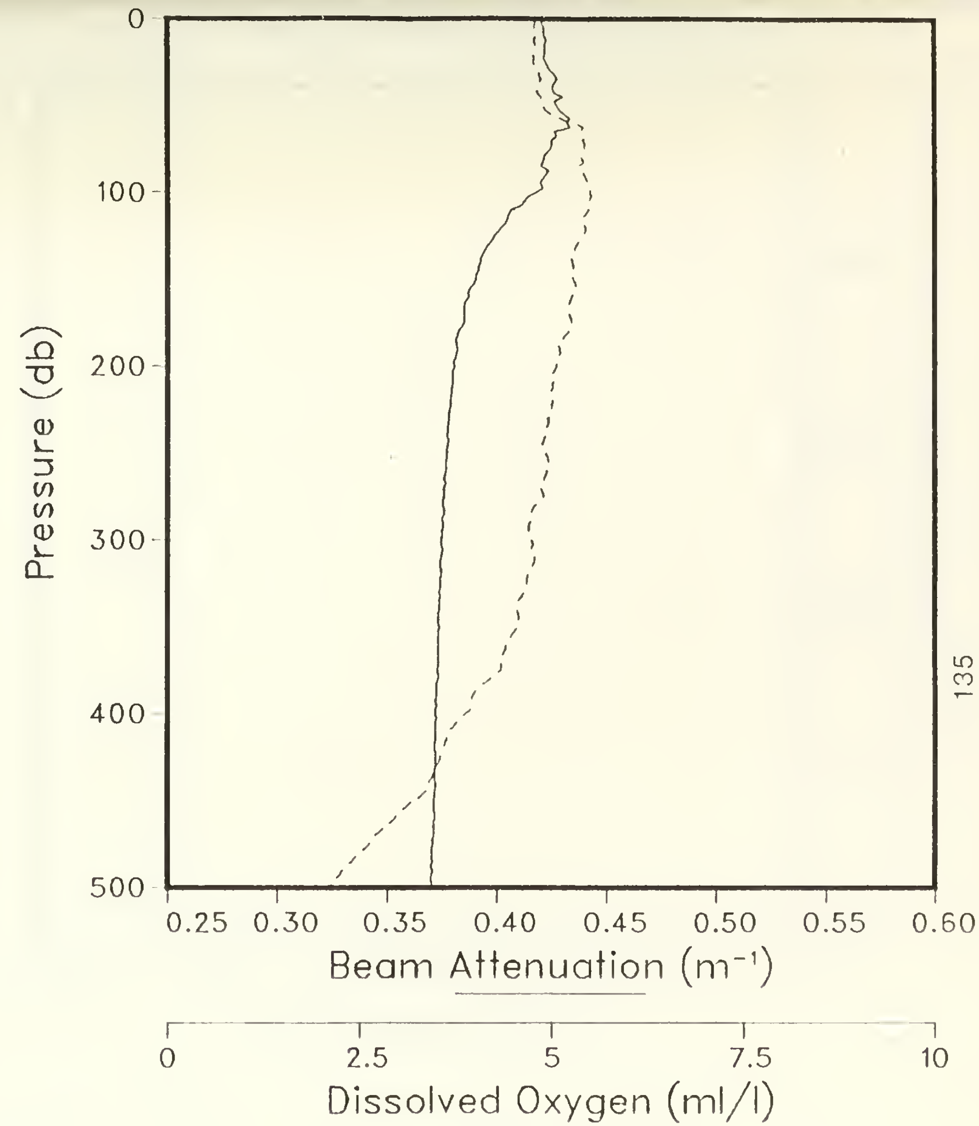


Latitude: 30.035°
Longitude: 141.368°

Date: 11/1/82
Time: 1832:50 GMT

R/V ACANIA CRUISE ODEX3 STATION 77

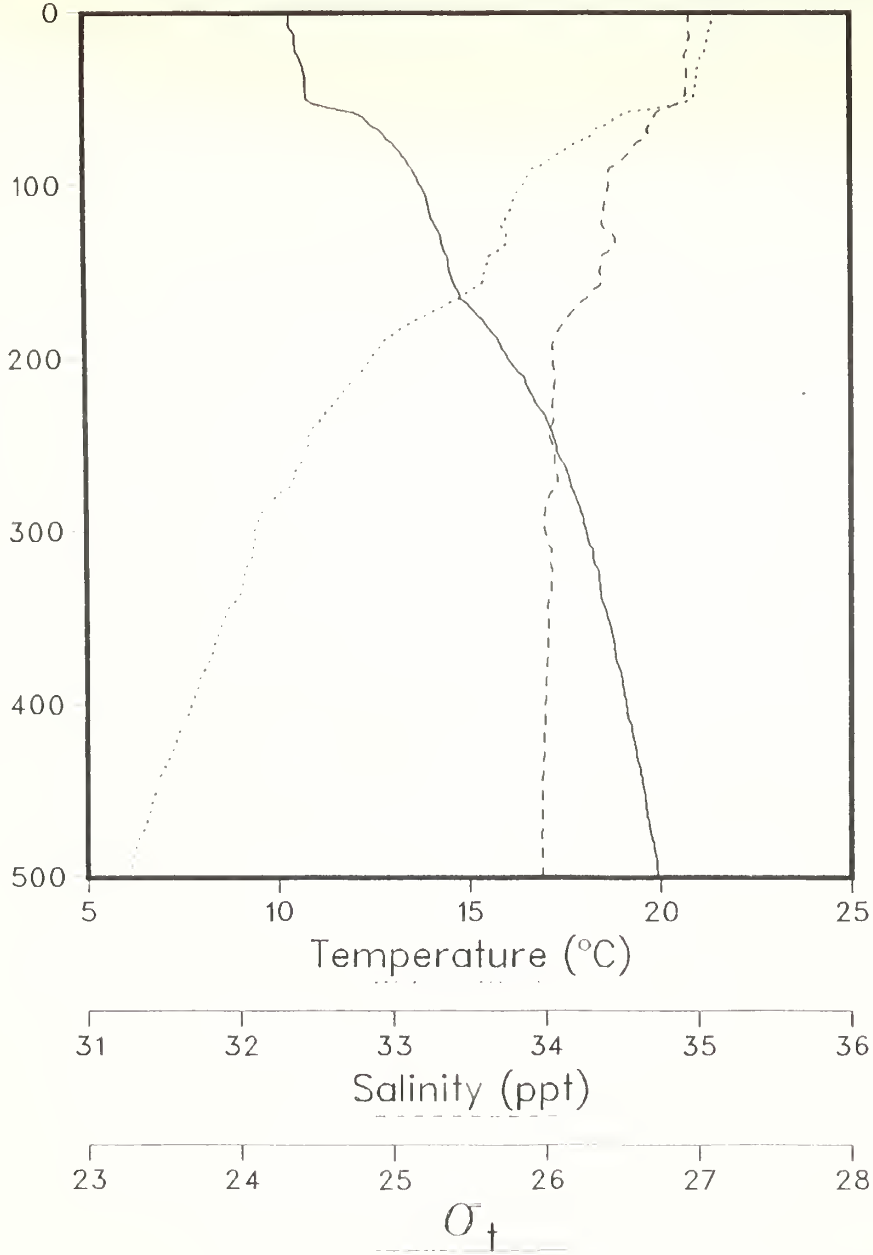


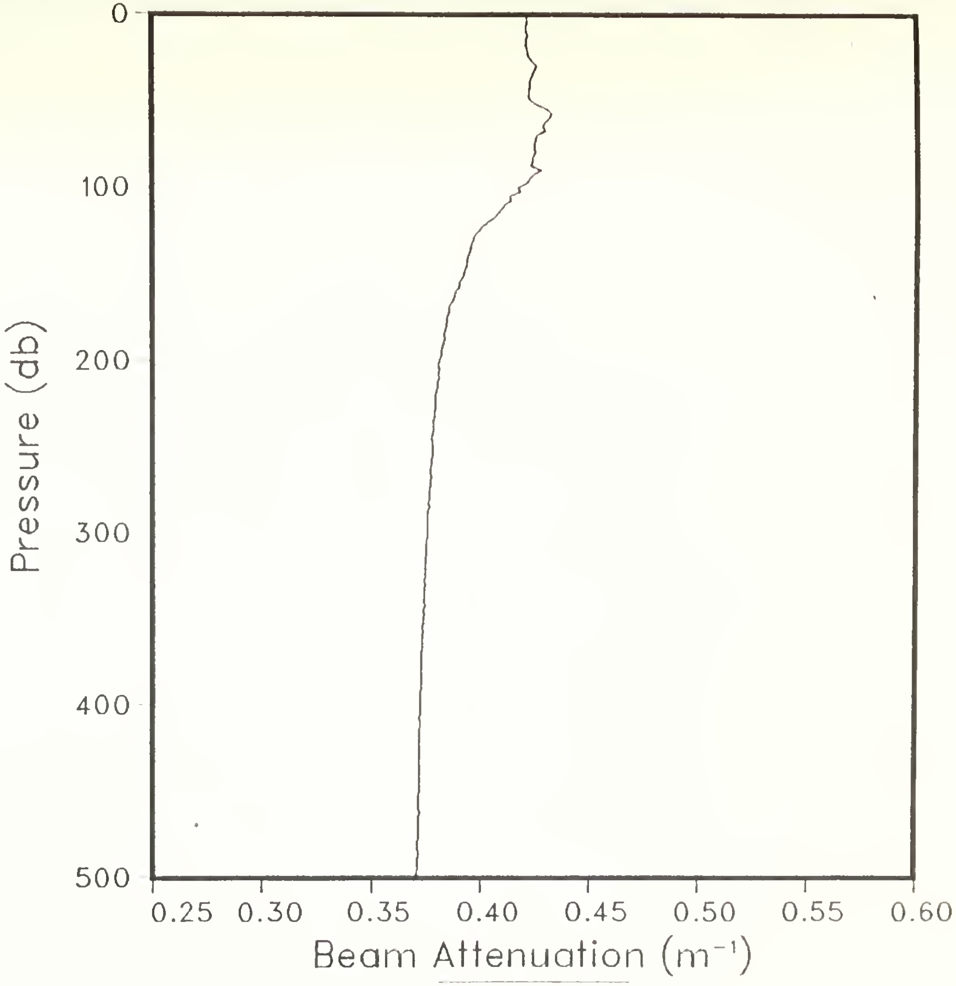


Latitude: 30.017°
Longitude: 141.350°

Date: 11/1/82
Time: 2218:11 GMT

R/V ACANIA CRUISE ODEX3 STATION 77B

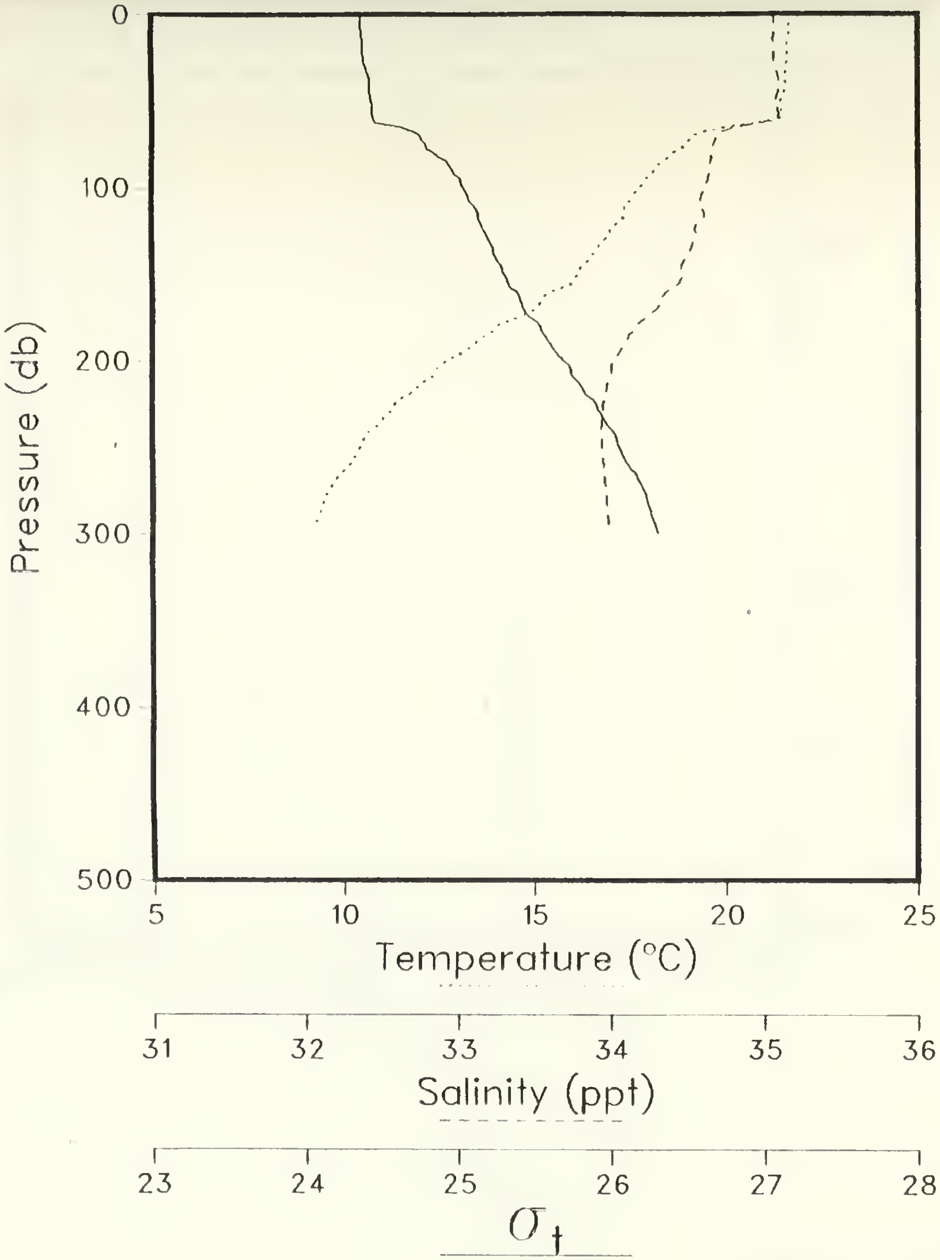


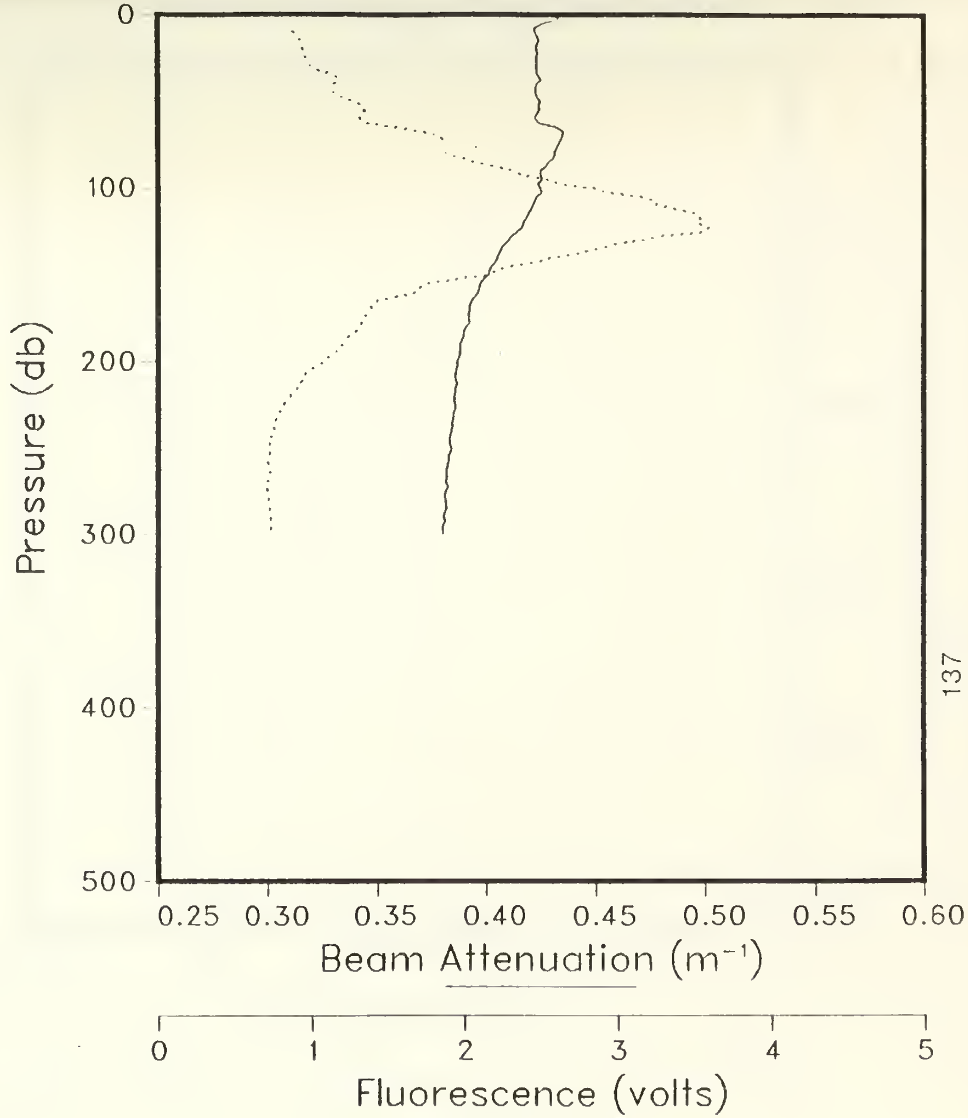


Latitude: 30.024°
Longitude: 141.355°

Date: 11/2/82
Time: 328:06 GMT

R/V ACANIA CRUISE ODEX3 STATION 77C

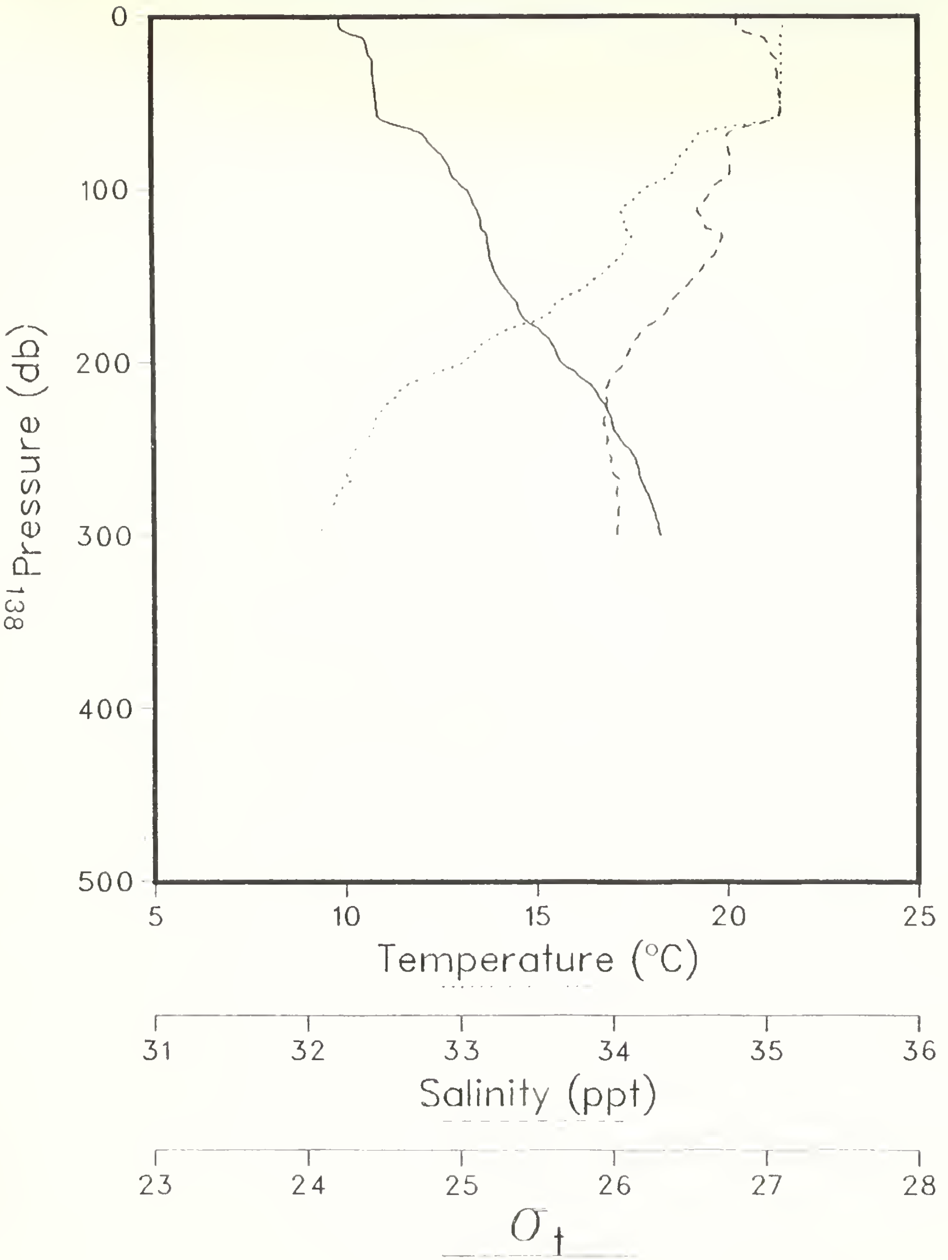


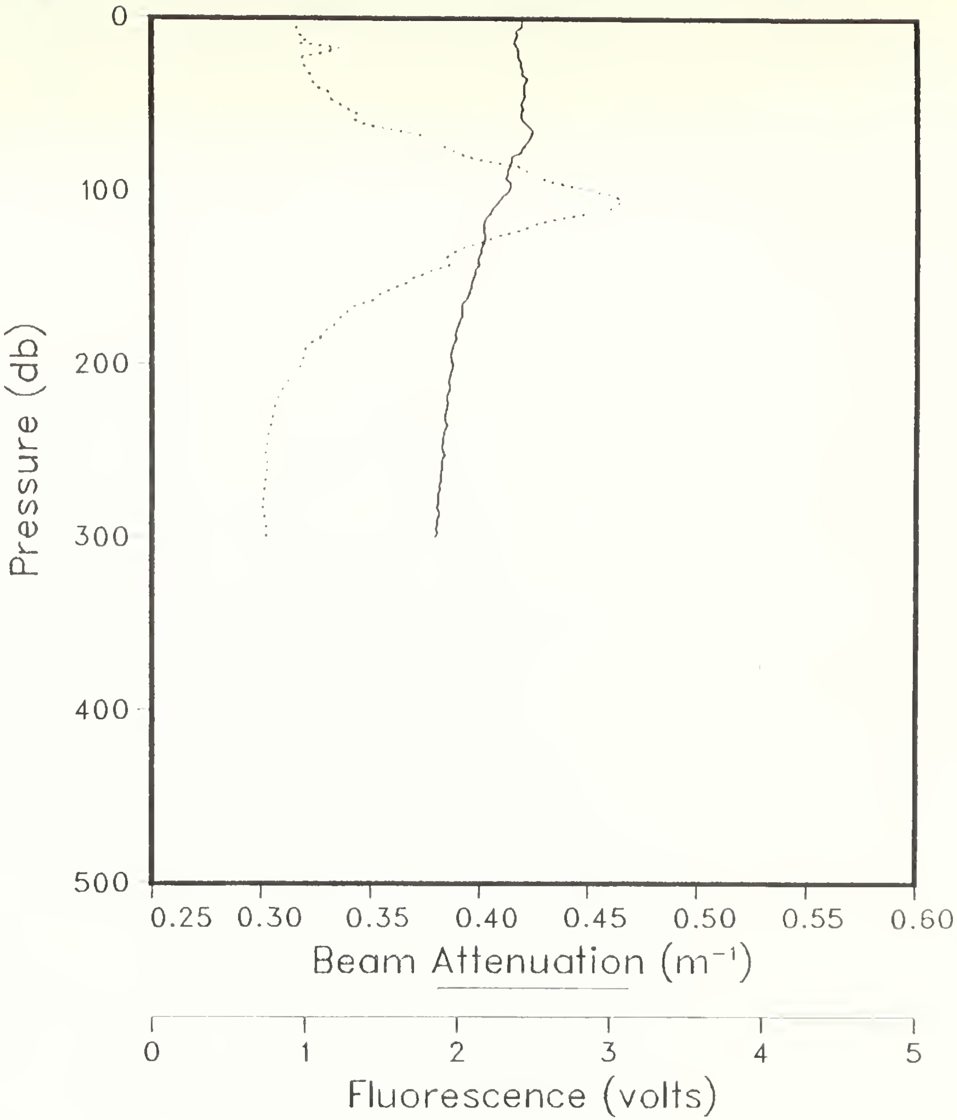


Latitude: 30.018°
Longitude: 141.848°

Date: 11/2/82
Time: 911:10 GMT

R/V ACANIA CRUISE ODEX3 STATION 78

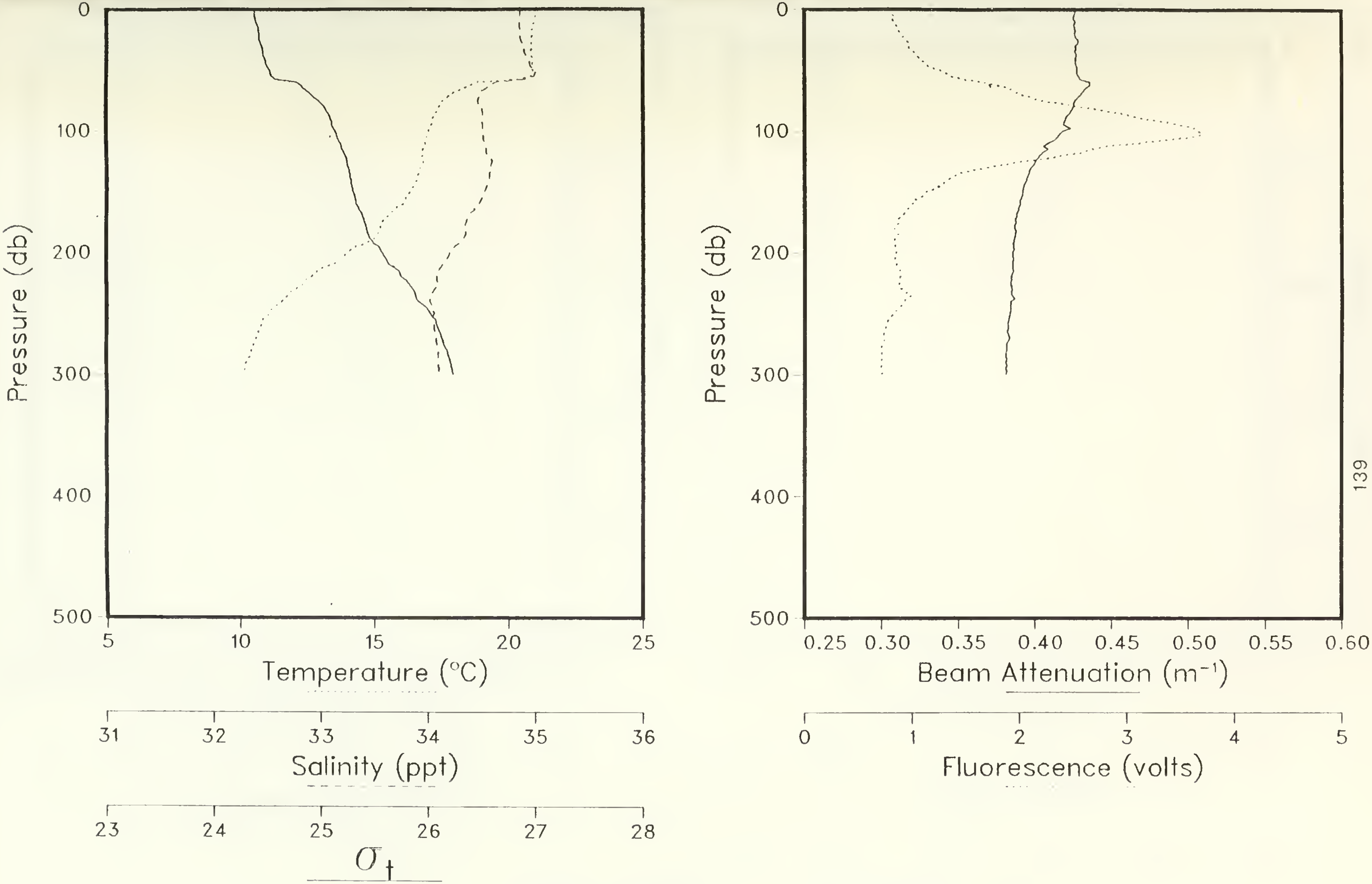




Latitude: 30.936°
Longitude: 140.867°

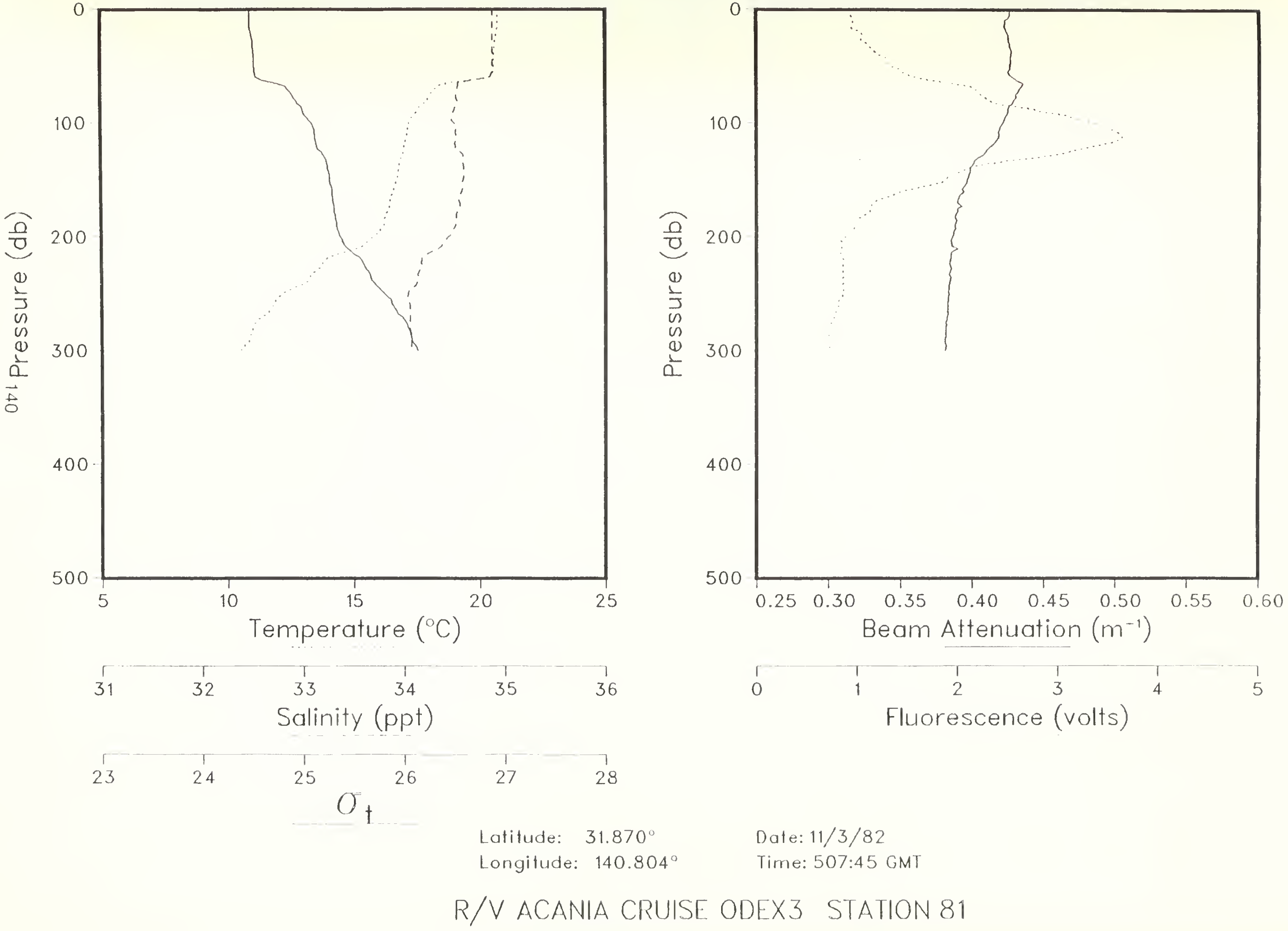
Date: 11/2/82
Time: 1706:02 GMT

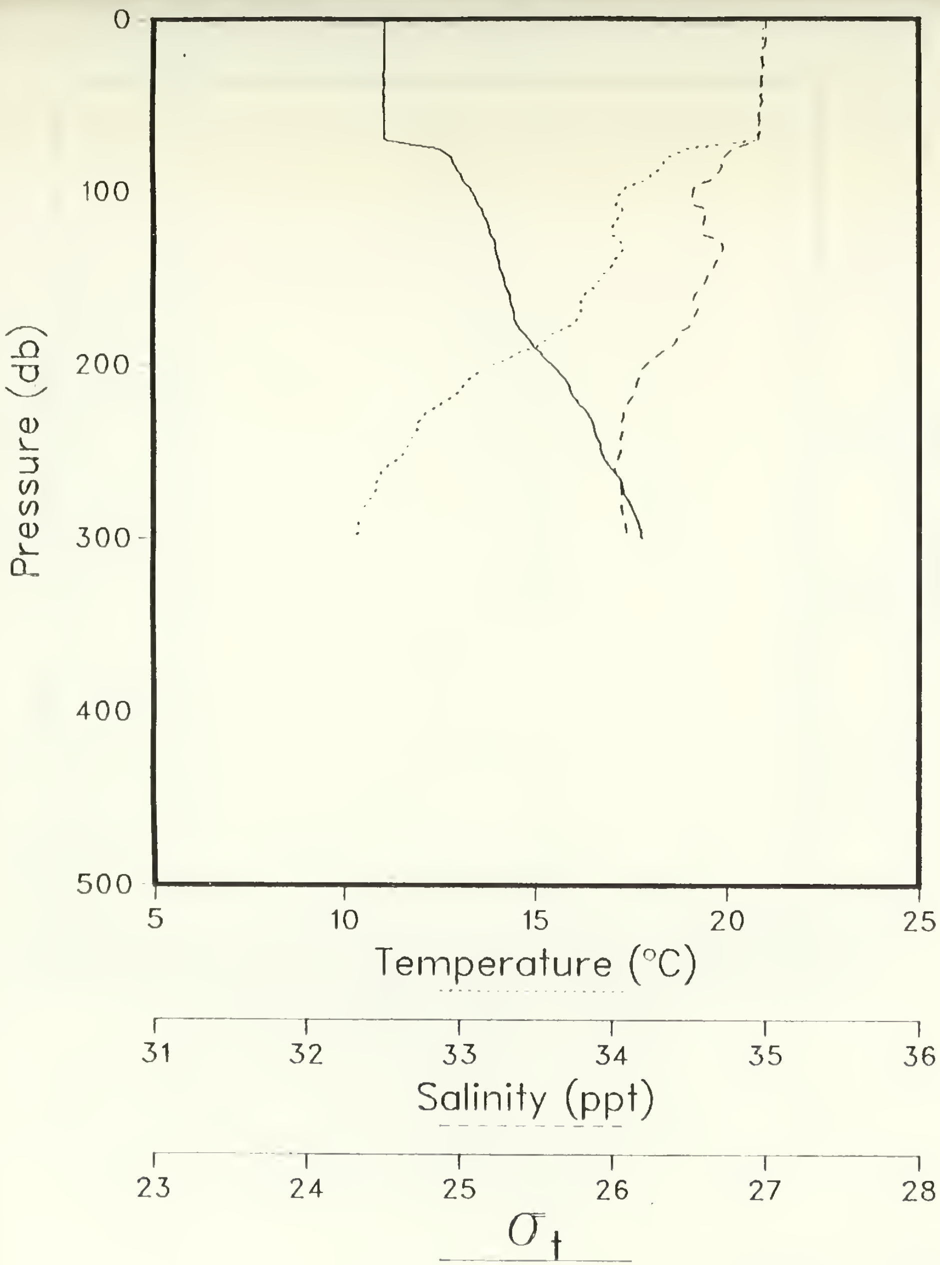
R/V ACANIA CRUISE ODEX3 STATION 79

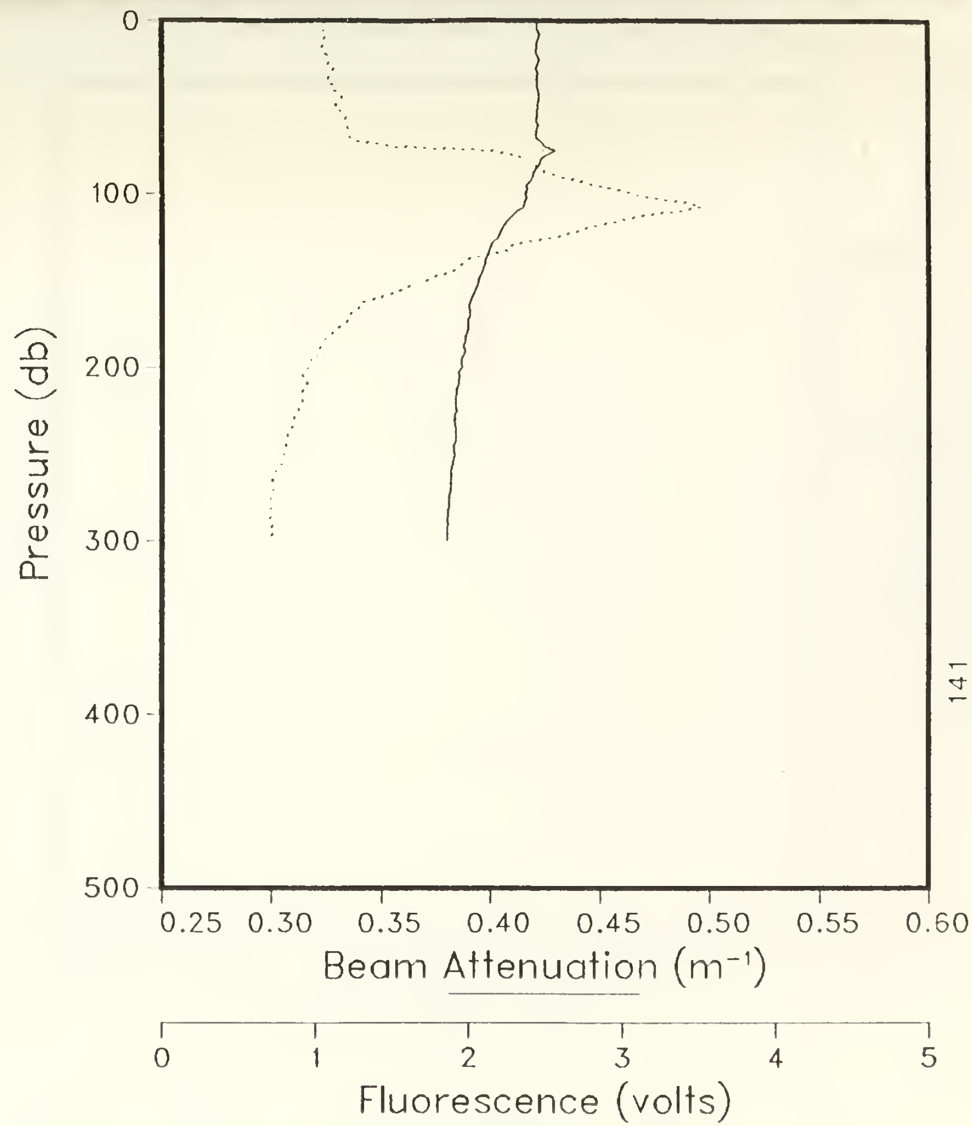


Latitude: 31.383° Date: 11/3/82
Longitude: 140.848° Time: 27:40 GMT

R/V ACANIA CRUISE ODEX3 STATION 80


Pressure (db)
0
100
200
300
400
500
5
10
15
20
25
Temperature (°C)
31
32
33
34
35
36
Salinity (ppt)
23
24
25
26
27
28
σ_t
Pressure (db)
0
100
200
300
400
500
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
Beam Attenuation (m^{-1})
0
1
2
3
4
5
Fluorescence (volts)
Latitude: 31.870°
Longitude: 140.804°
Date: 11/3/82
Time: 507:45 GMT
R/V ACANIA CRUISE ODEX3 STATION 81

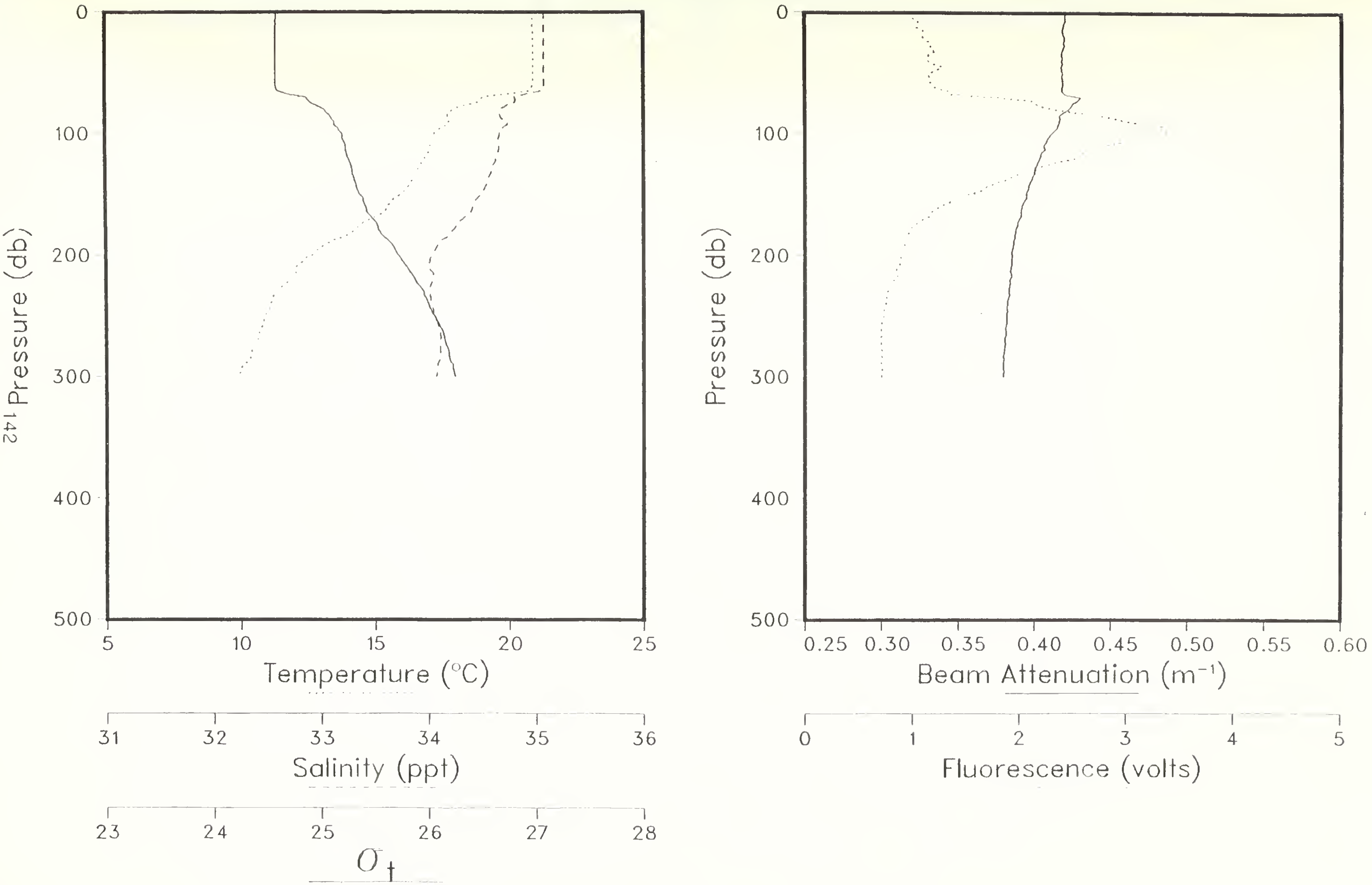




Latitude: 32.472°
Longitude: 140.835°

Date: 11/3/82
Time: 1114:46 GMT

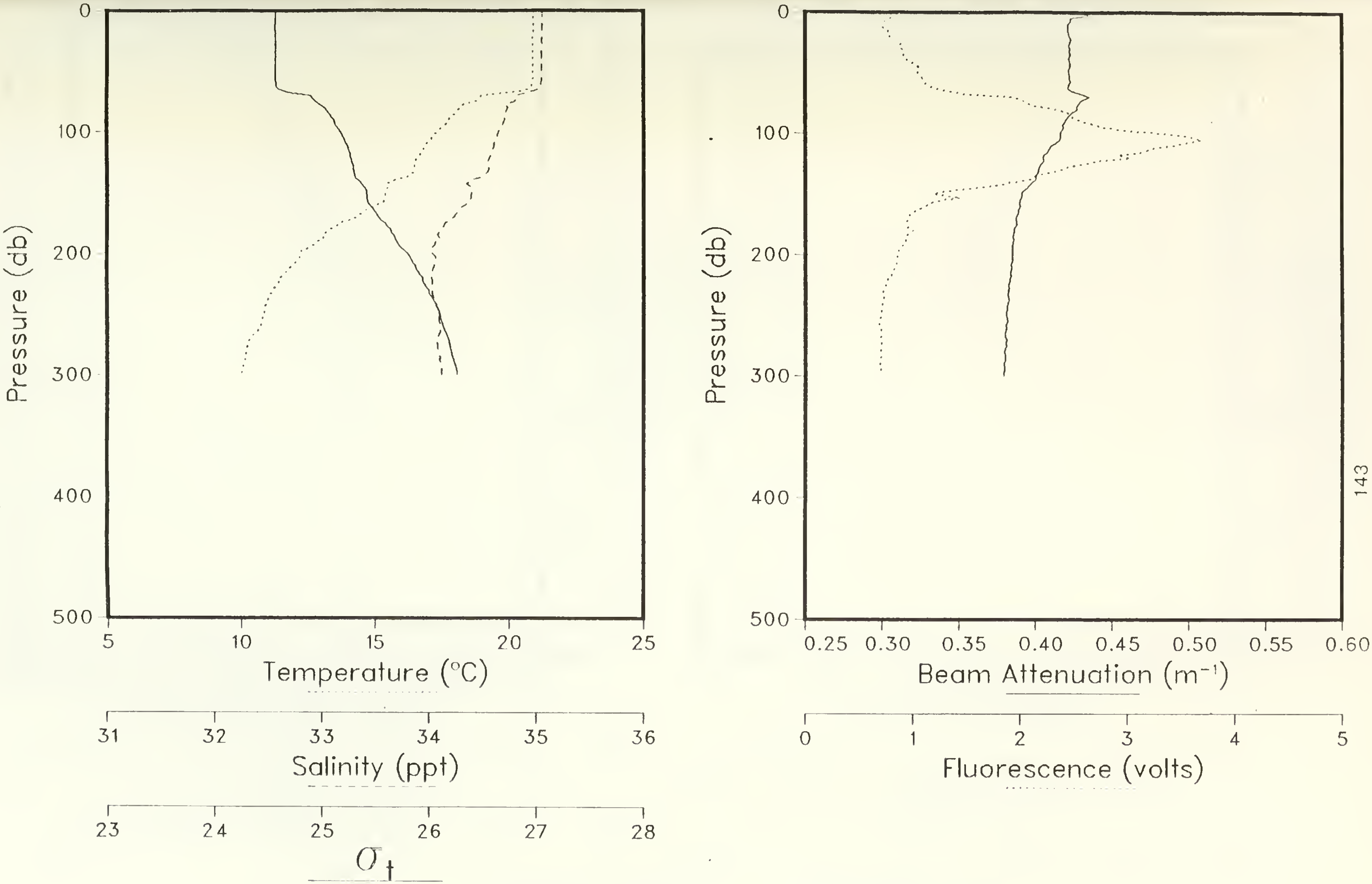
R/V ACANIA CRUISE ODEX3 STATION 82



Latitude: 32.887°
Longitude: 140.882°

Date: 11/3/82
Time: 1710:22 GMT

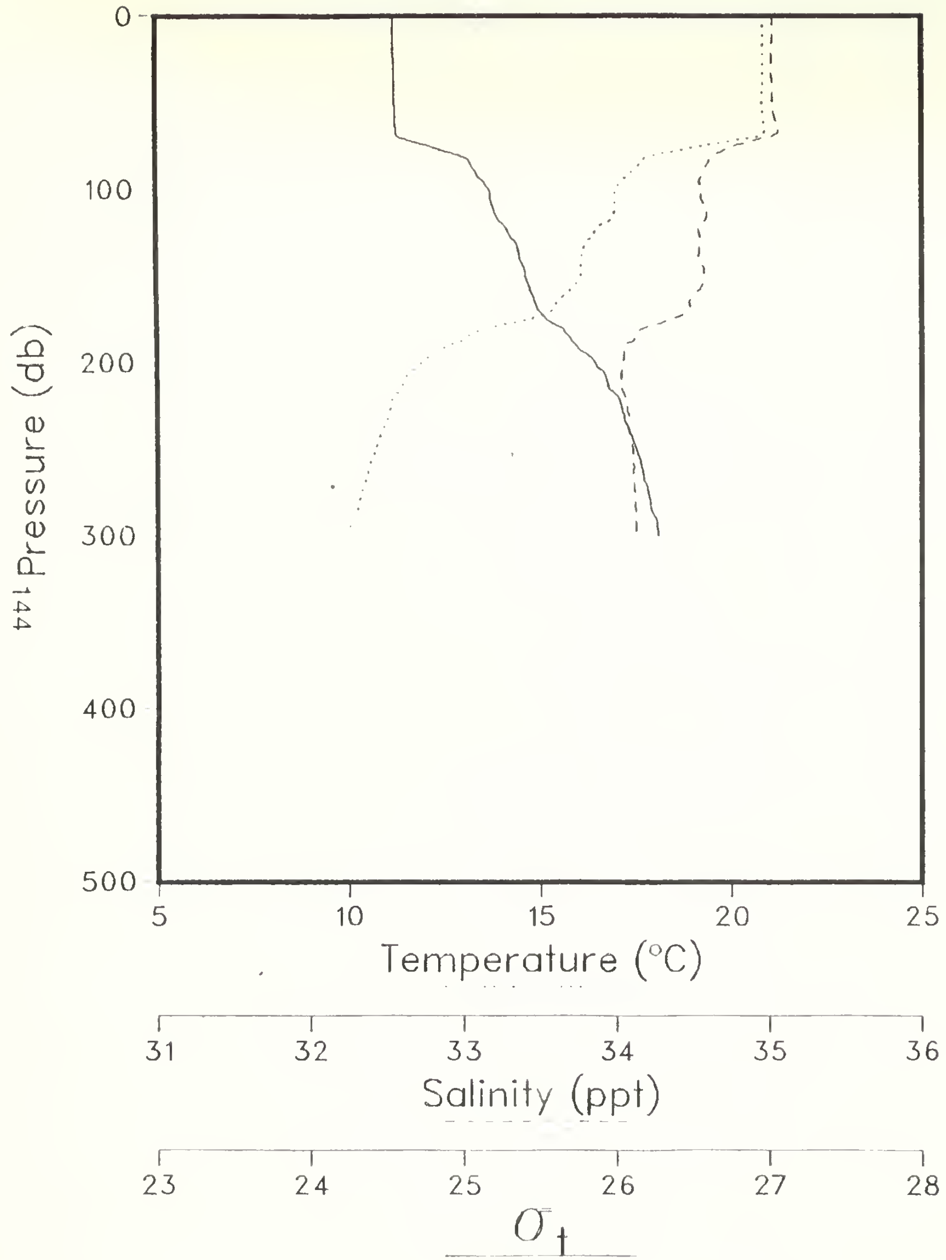
R/V ACANIA CRUISE ODEX3 STATION 83

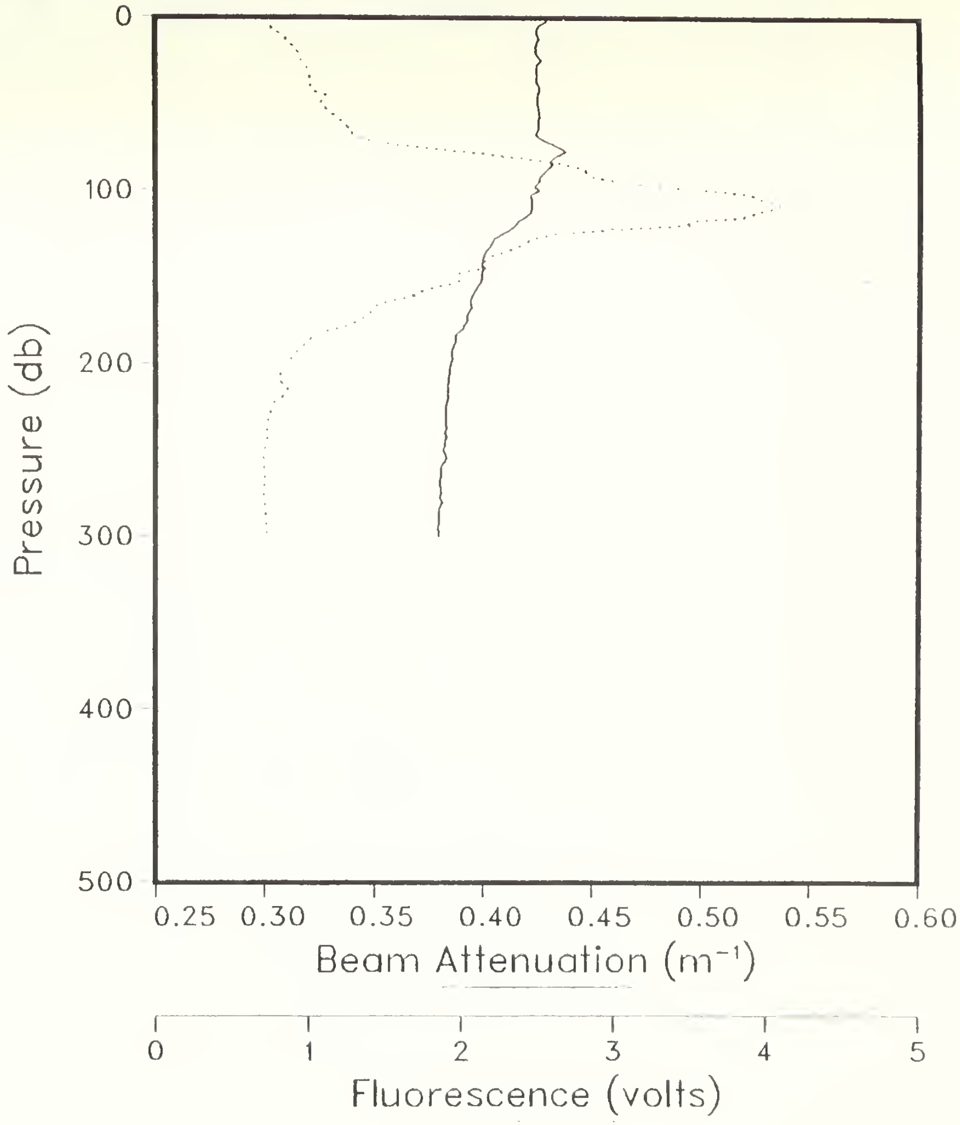


Latitude: 32.991°
Longitude: 140.797°

Date: 11/3/82
Time: 2054:48 GMT

R/V ACANIA CRUISE ODEX3 STATION 84

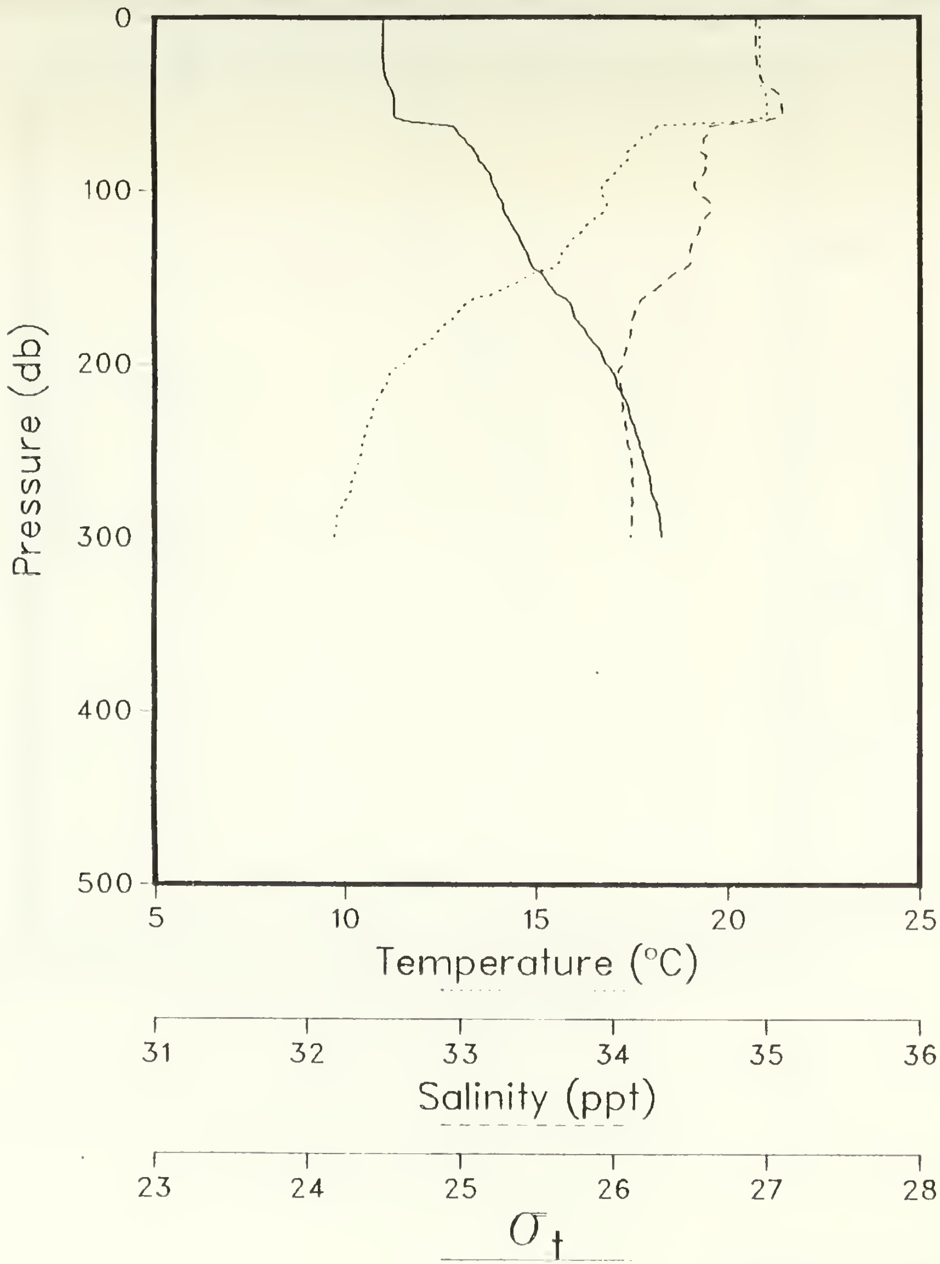


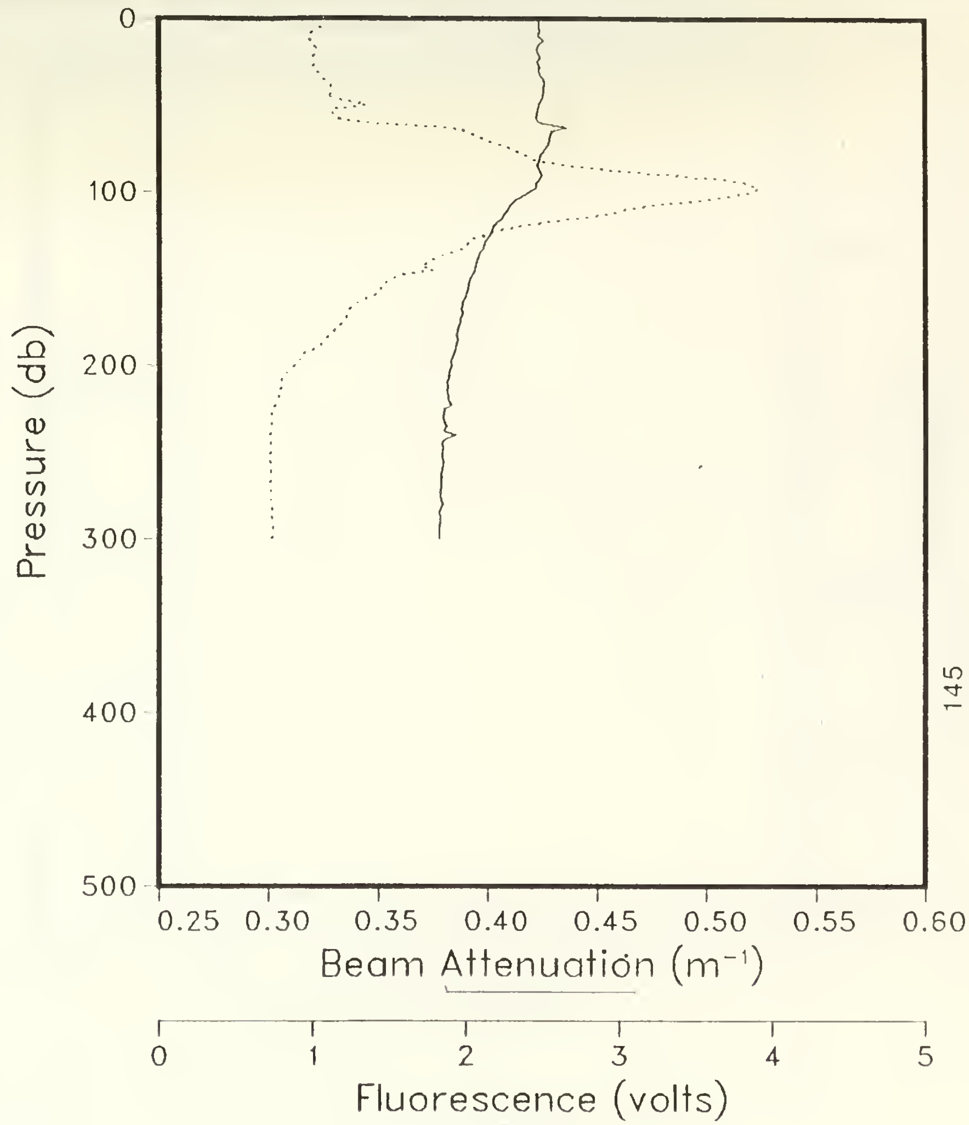


Latitude: 33.084°
Longitude: 140.801°

Date: 11/3/82
Time: 2340:57 GMT

R/V ACANIA CRUISE ODEX3 STATION 85

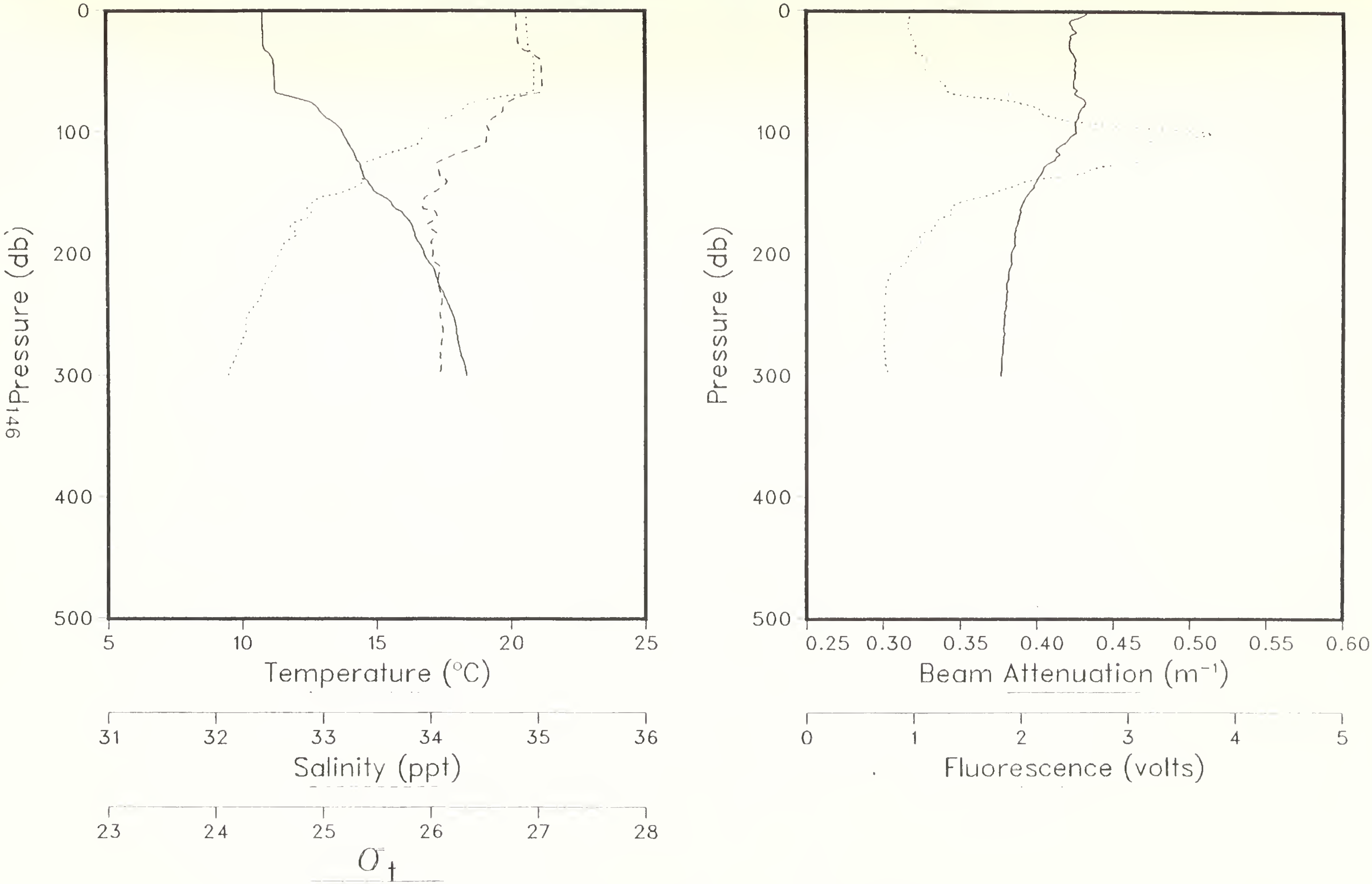




Latitude: 33.230°
Longitude: 140.875°

Date: 11/4/82
Time: 228:22 GMT

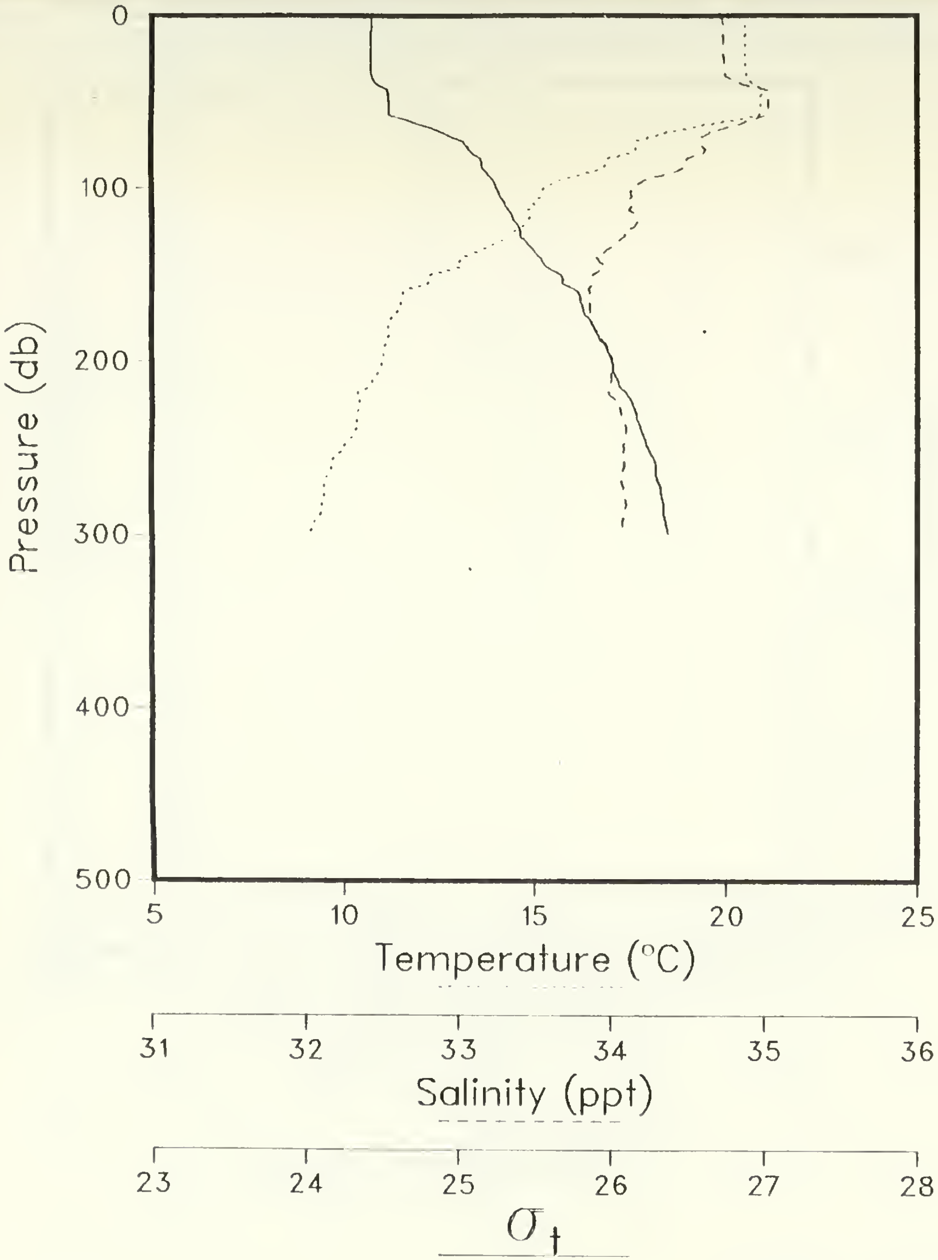
R/V ACANIA CRUISE ODEX3 STATION 86

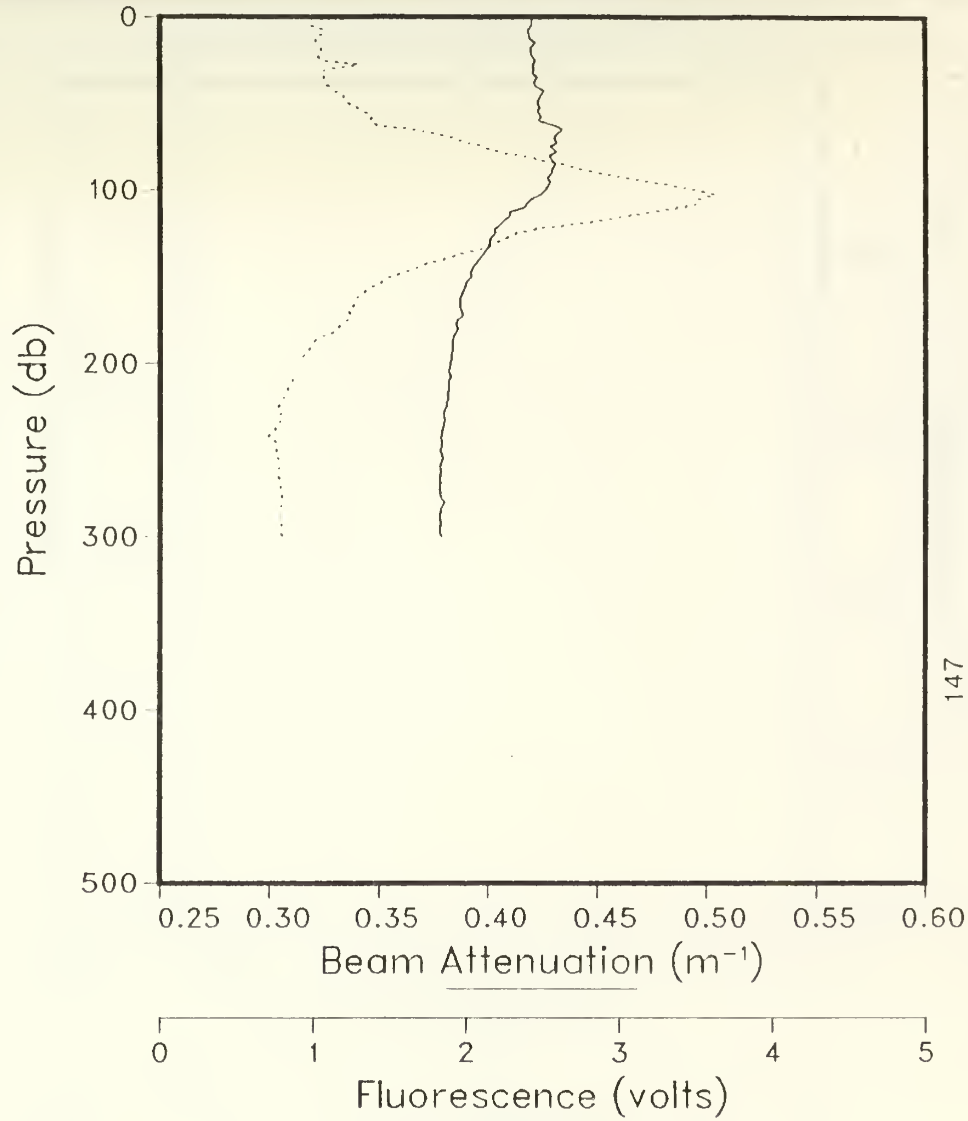


Latitude: 33.348°
Longitude: 140.760°

Date: 11/4/82
Time: 418:32 GMT

R/V ACANIA CRUISE ODEX3 STATION 87

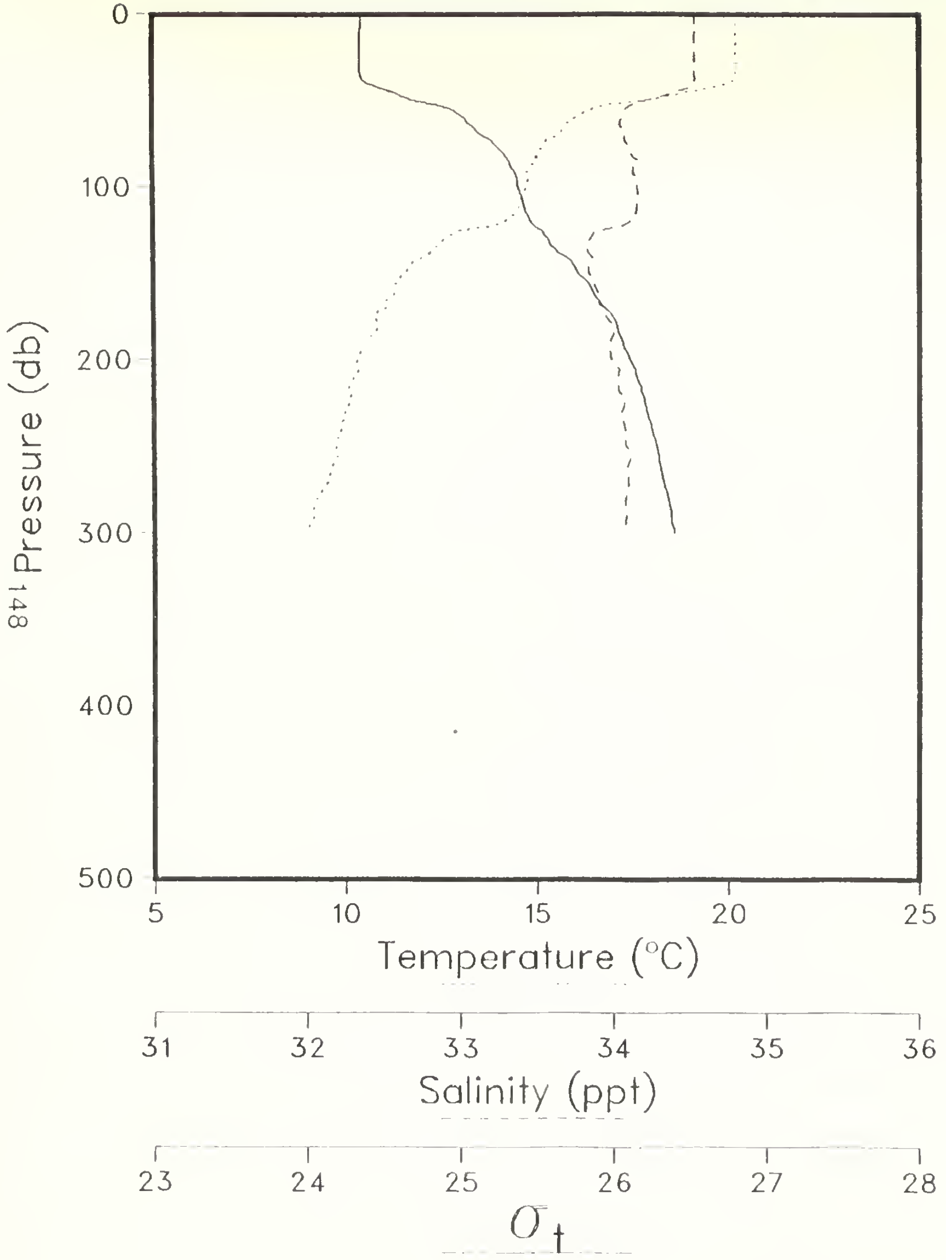


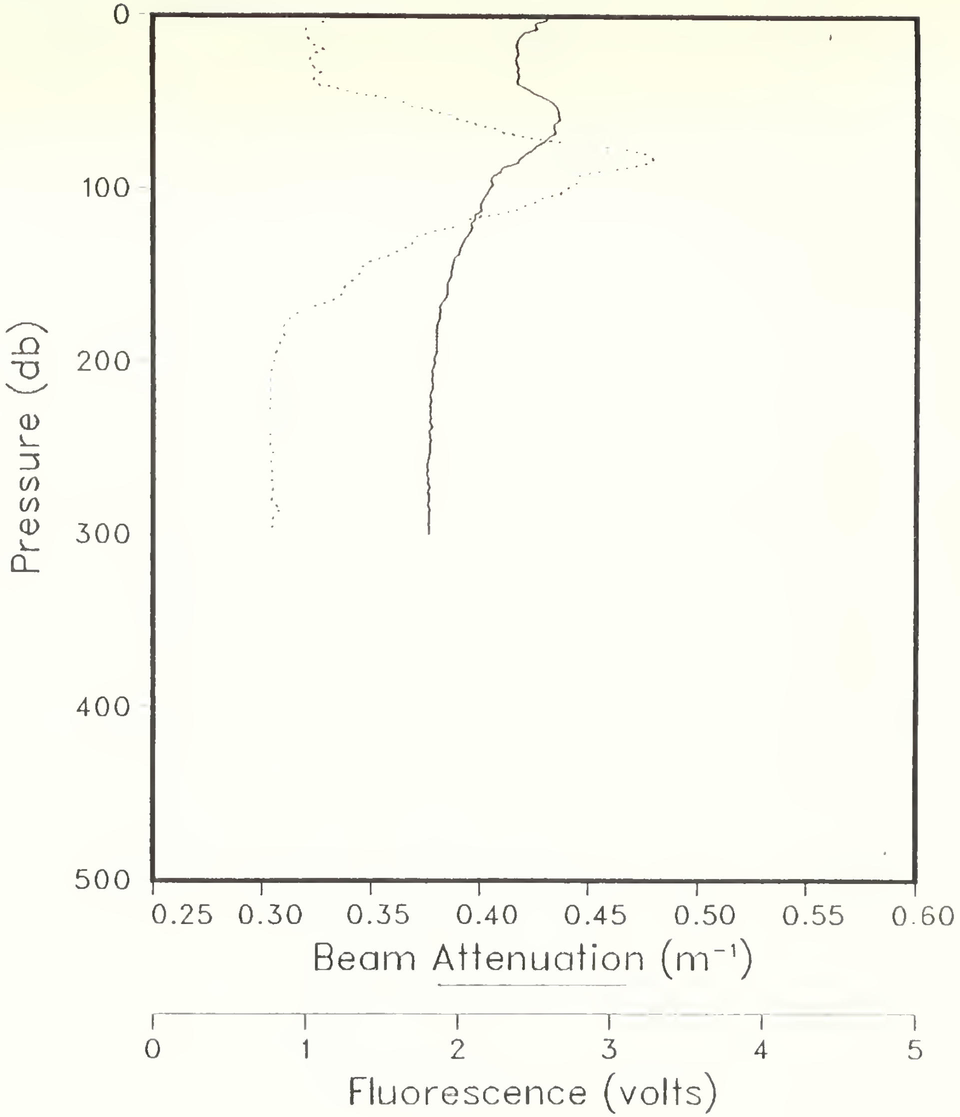


Latitude: 33.452°
Longitude: 140.796°

Date: 11/4/82
Time: 720:15 GMT

R/V ACANIA CRUISE ODEX3 STATION 88

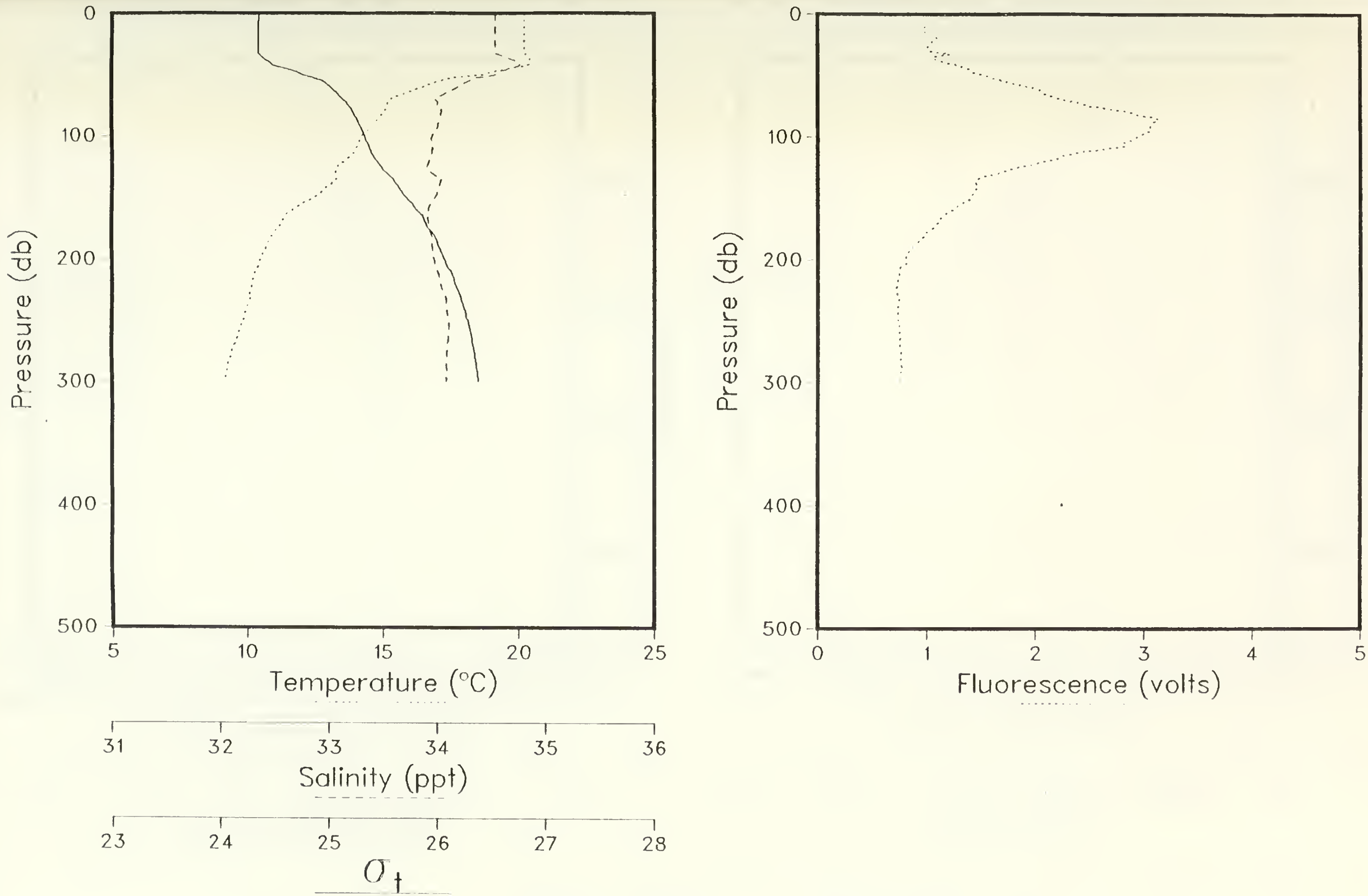




Latitude: 33.578°
Longitude: 140.853°

Date: 11/4/82
Time: 913:47 GMT

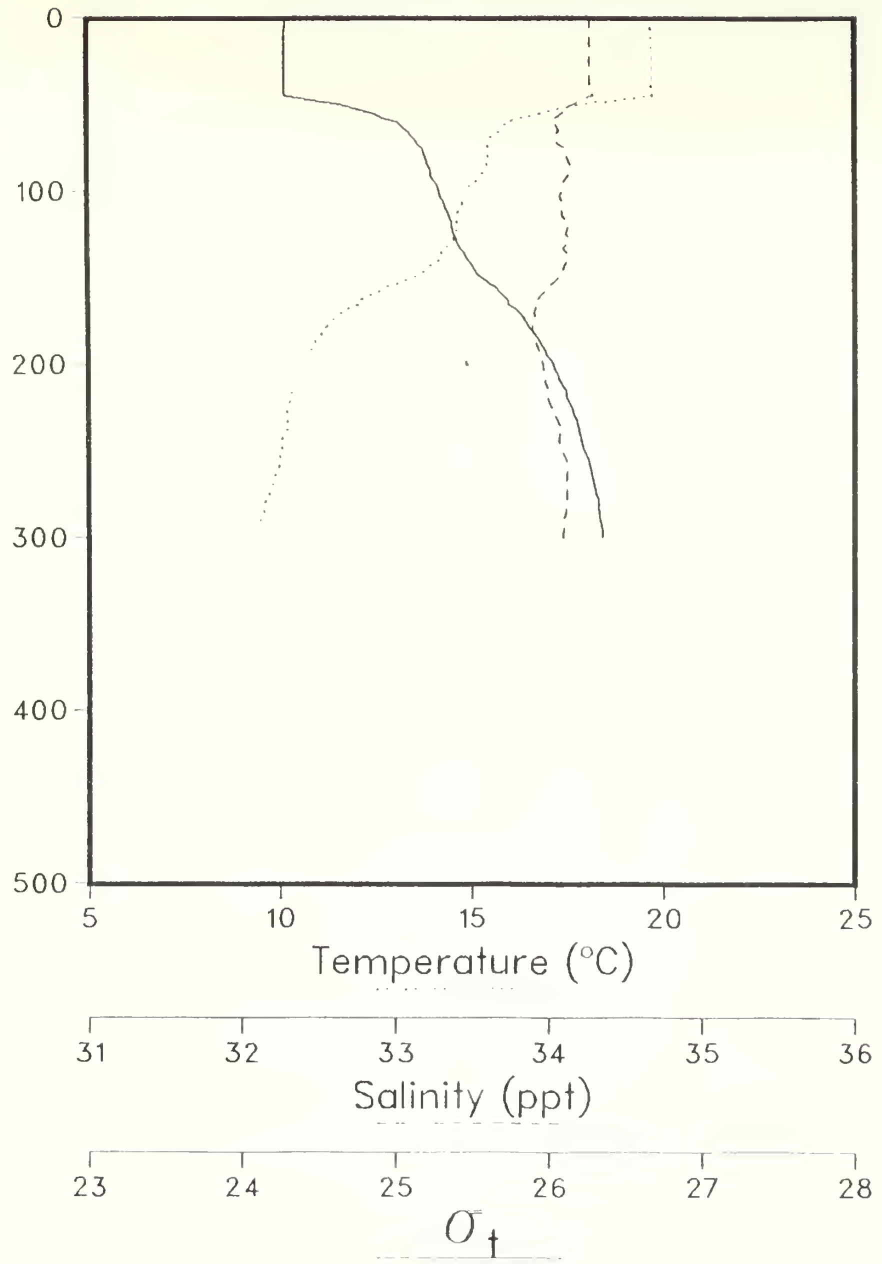
R/V ACANIA CRUISE ODEX3 STATION 89

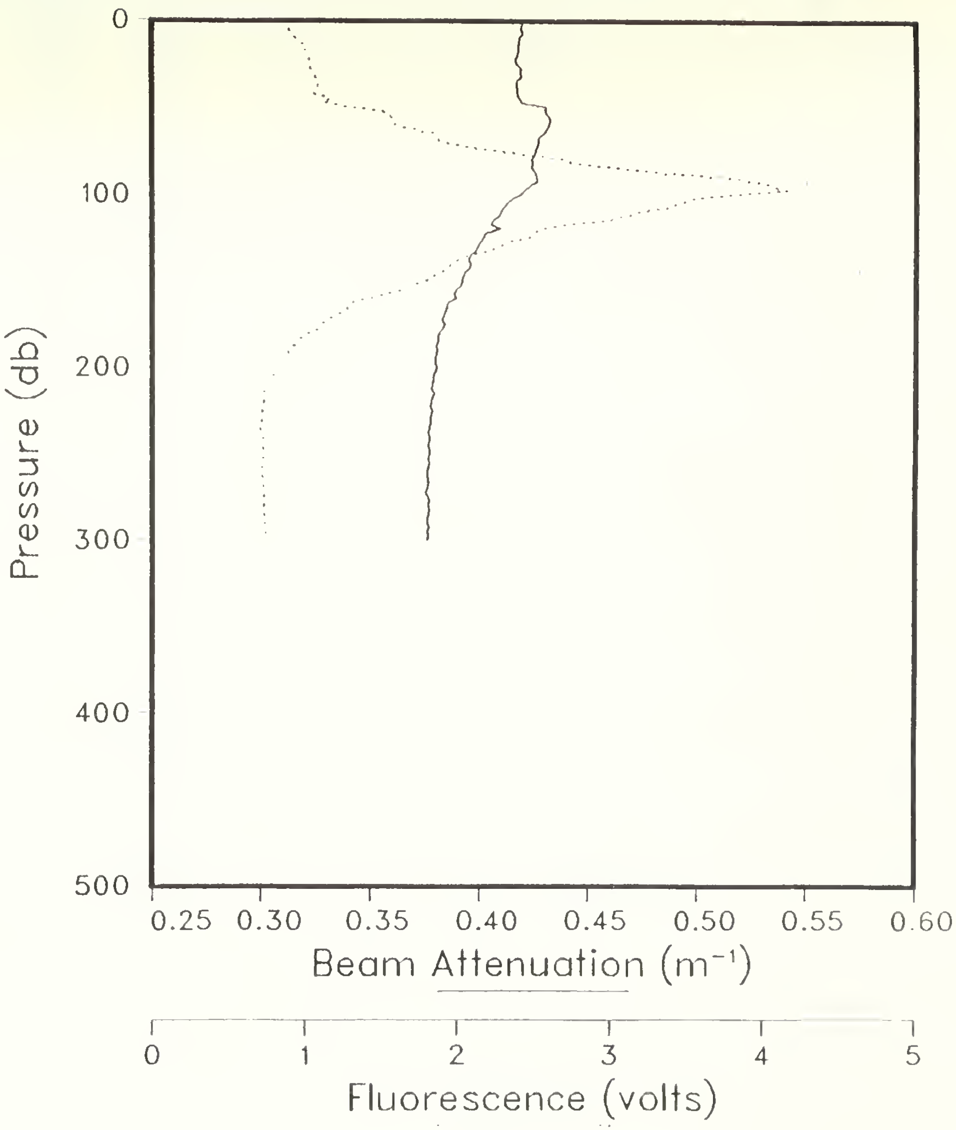


Latitude: 33.707° Longitude: 140.833°

Date: 11/4/82 Time: 1103:07 GMT

R/V ACANIA CRUISE ODEX3 STATION 90

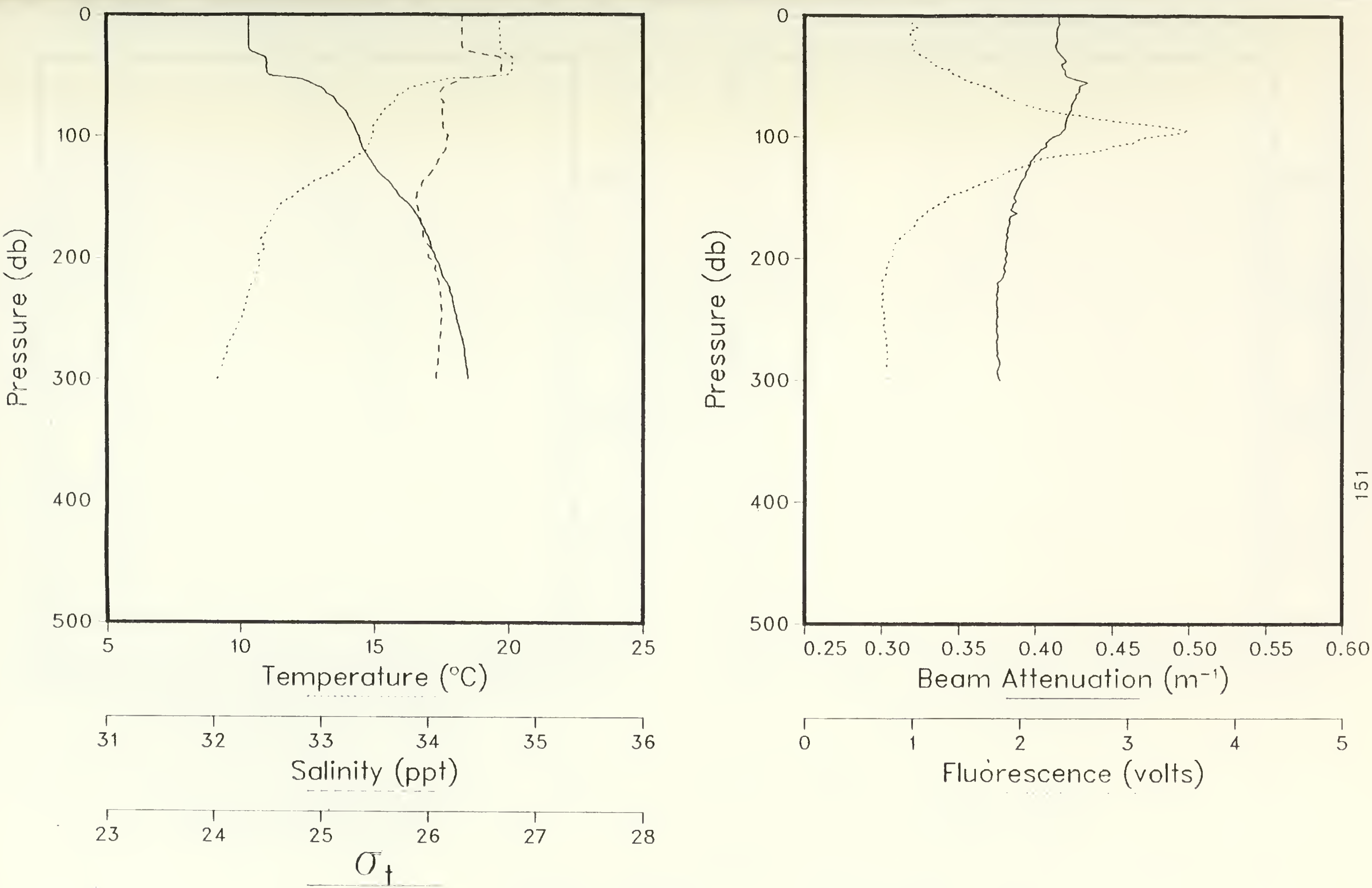




Latitude: 33.843°
Longitude: 140.915°

Date: 11/4/82
Time: 1254:56 GMT

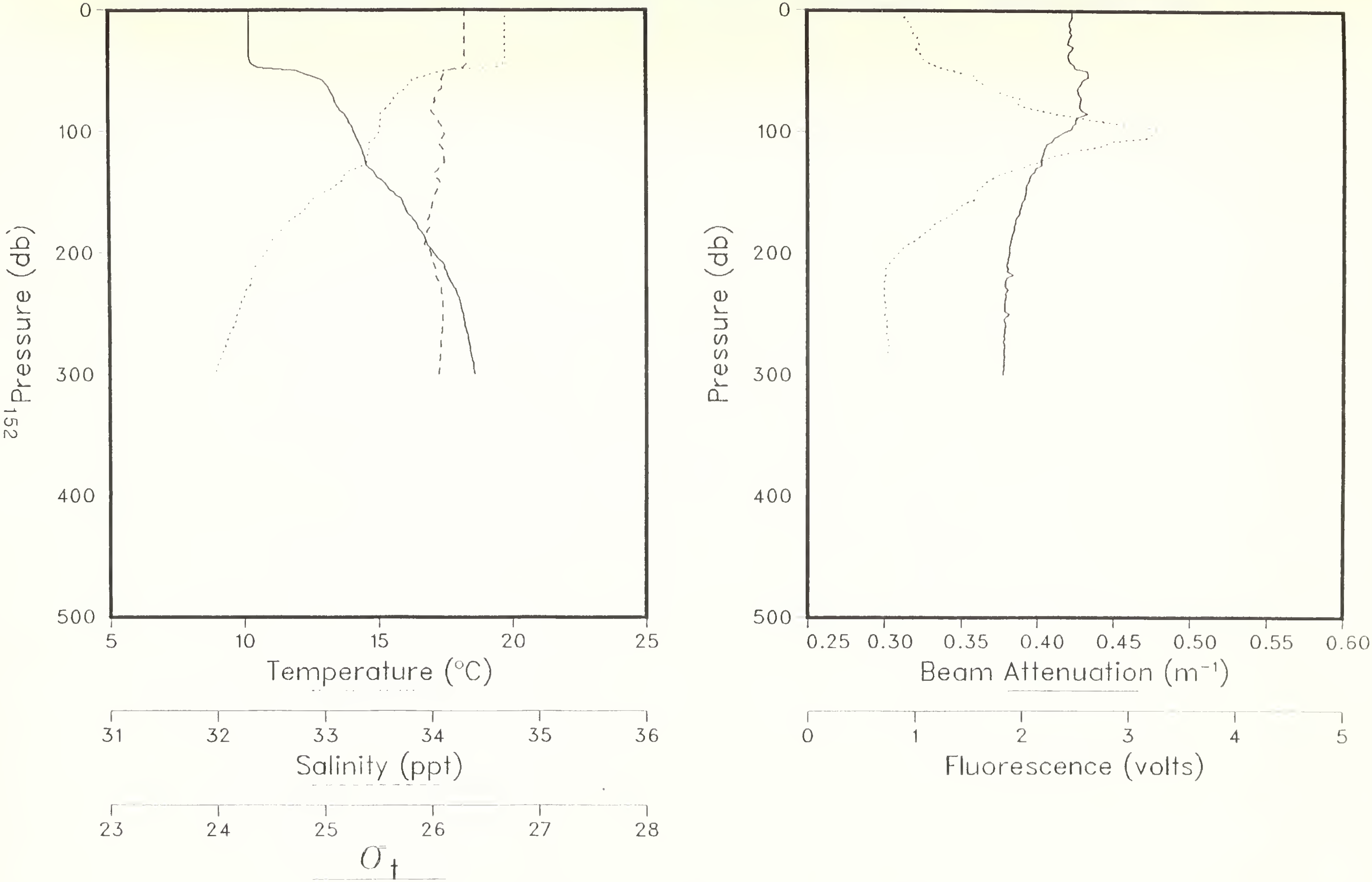
R/V ACANIA CRUISE ODEX3 STATION 91



Latitude: 33.938°
Longitude: 140.767°

Date: 11/4/82
Time: 1443:22 GMT

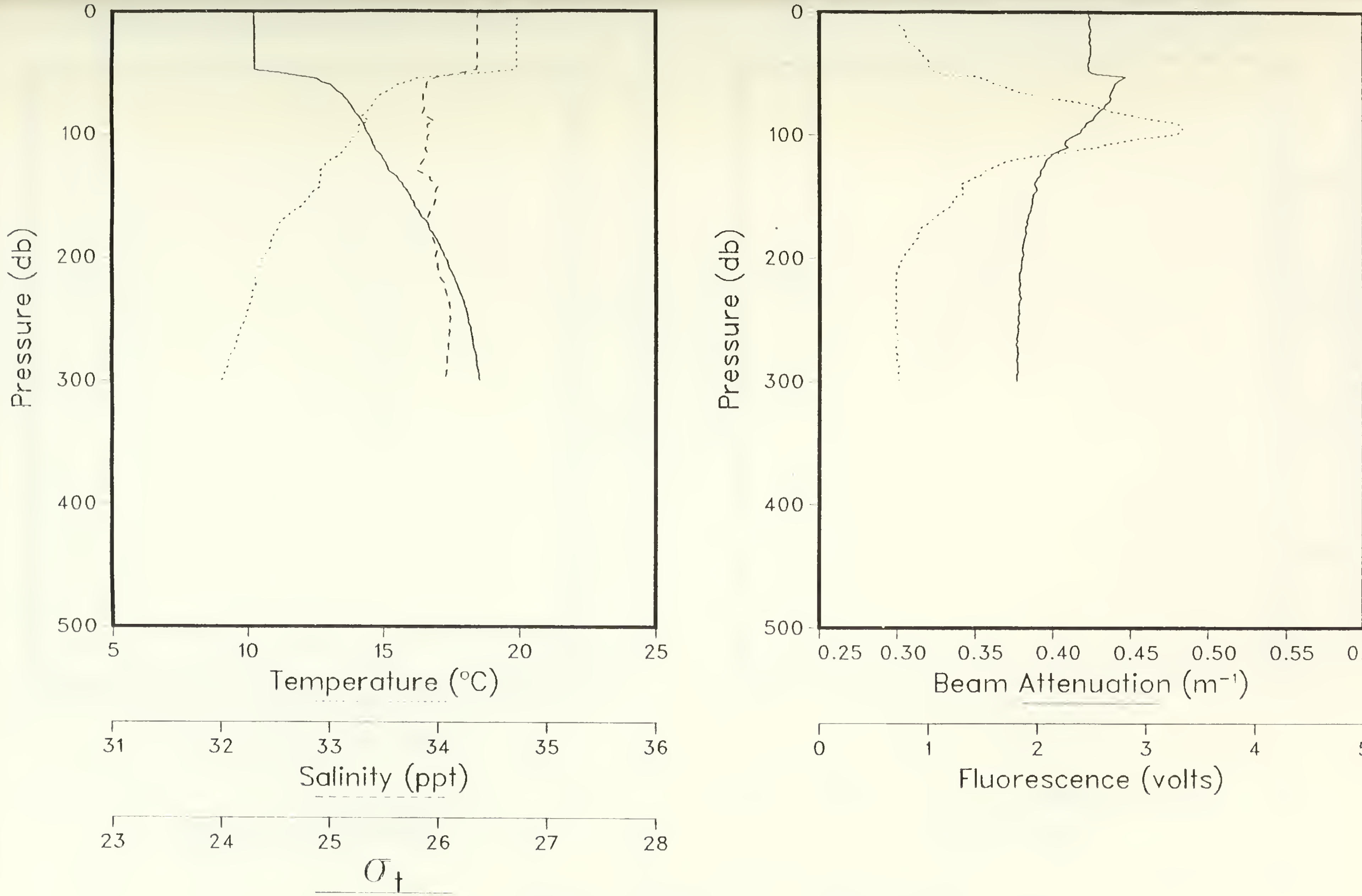
R/V ACANIA CRUISE ODEX3 STATION 92



Latitude: 33.833°
Longitude: 140.959°

Date: 11/4/82
Time: 1714:19 GMT

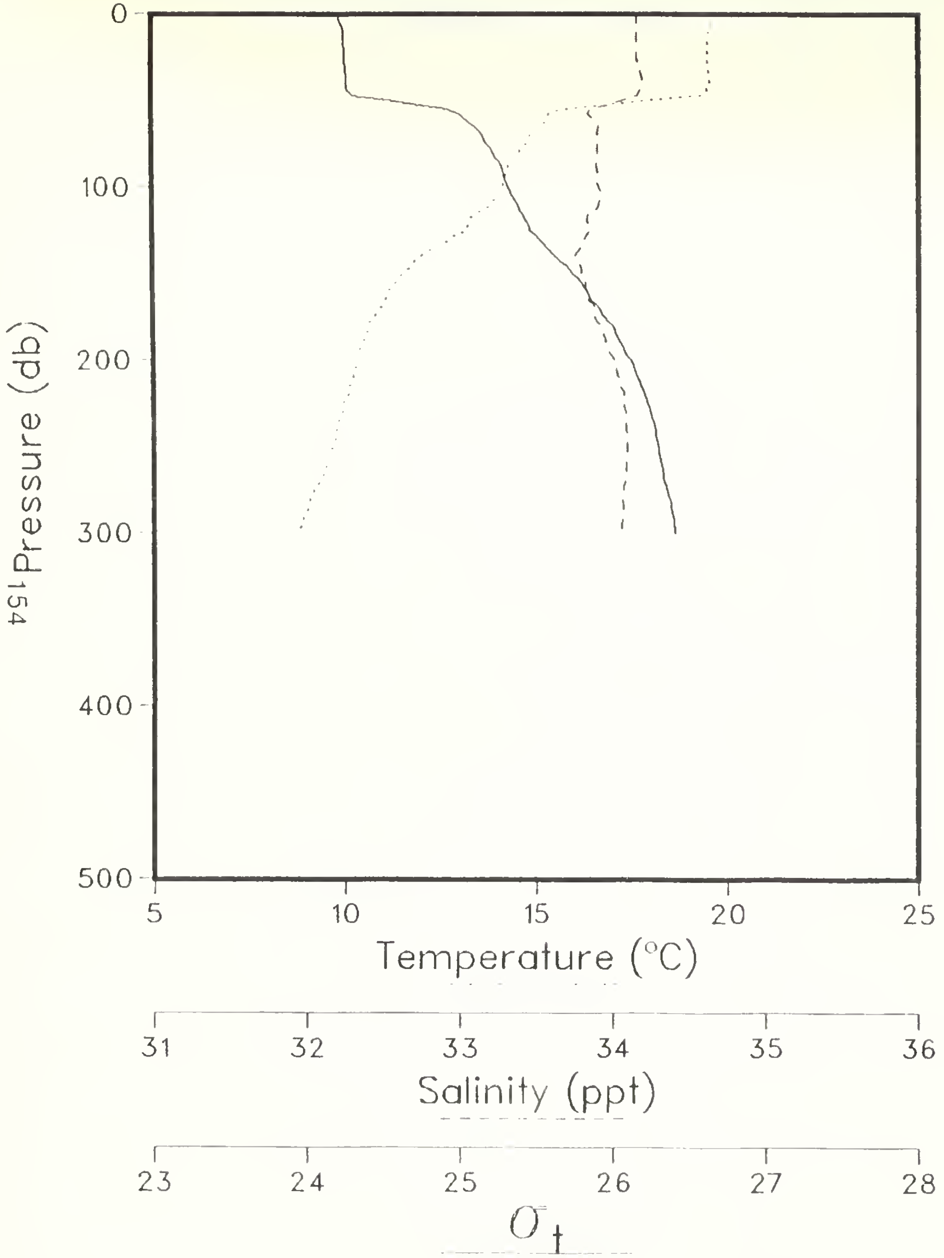
R/V ACANIA CRUISE ODEX3 STATION 93

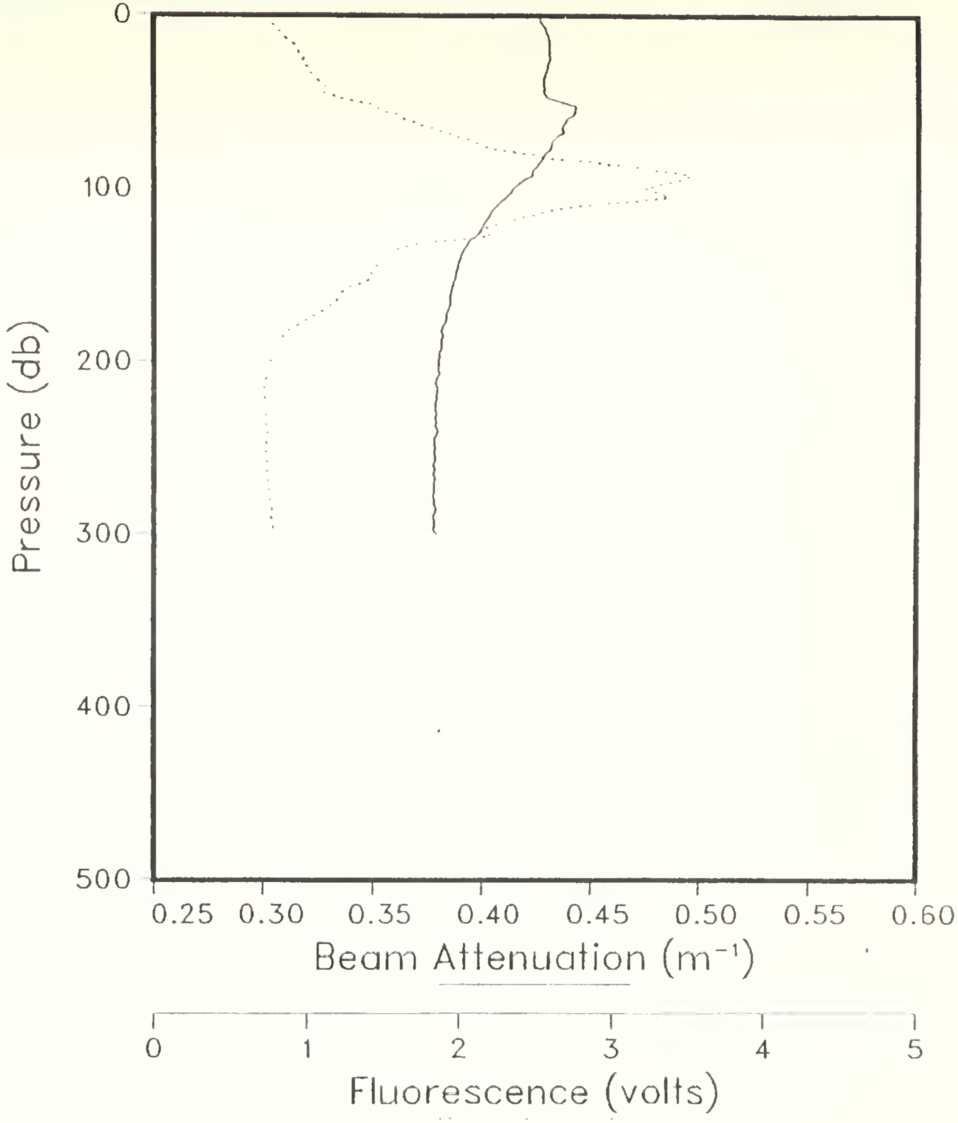


Latitude: 33.842°
Longitude: 141.058°

Date: 11/4/82
Time: 2005:24 GMT

R/V ACANIA CRUISE ODEX3 STATION 94

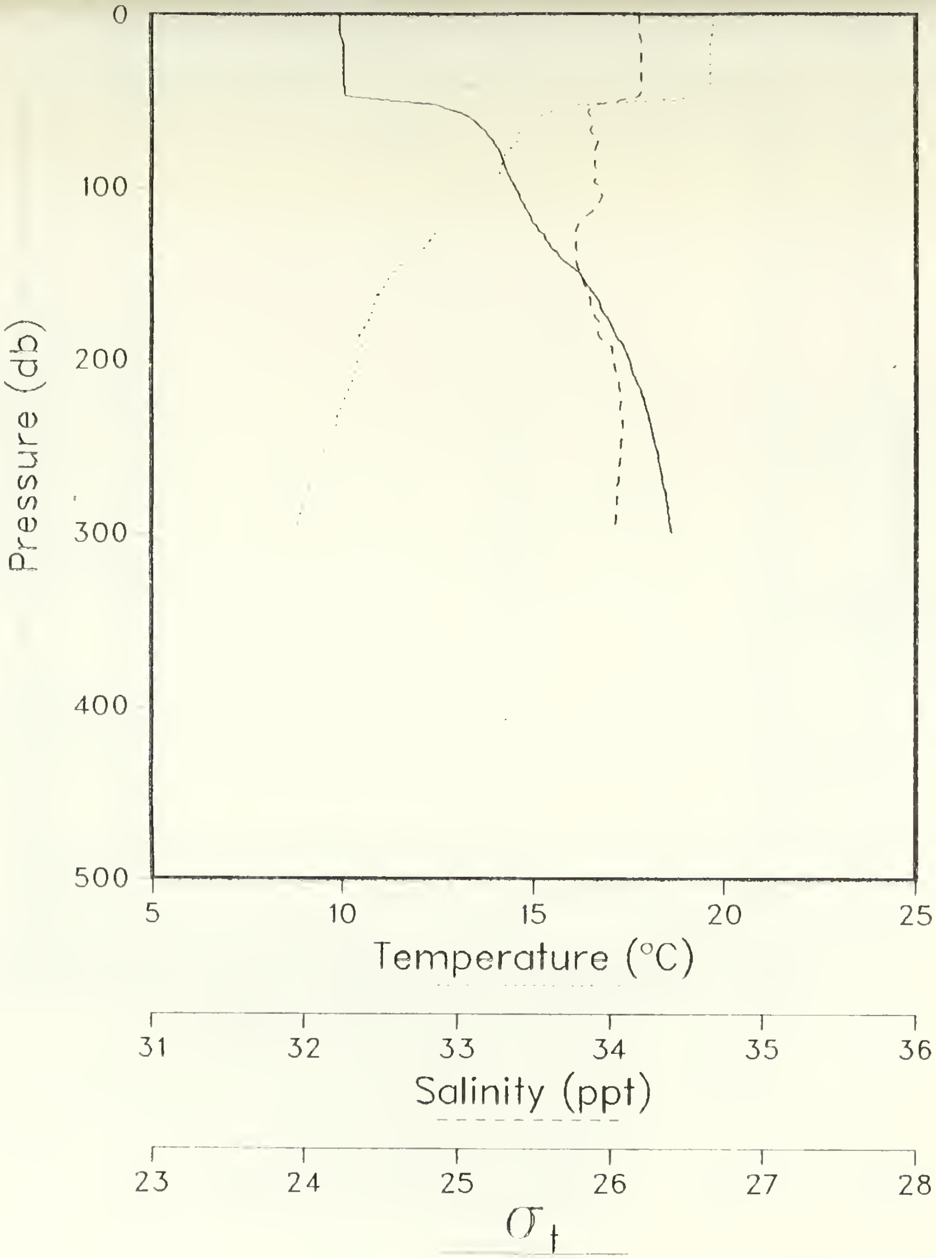


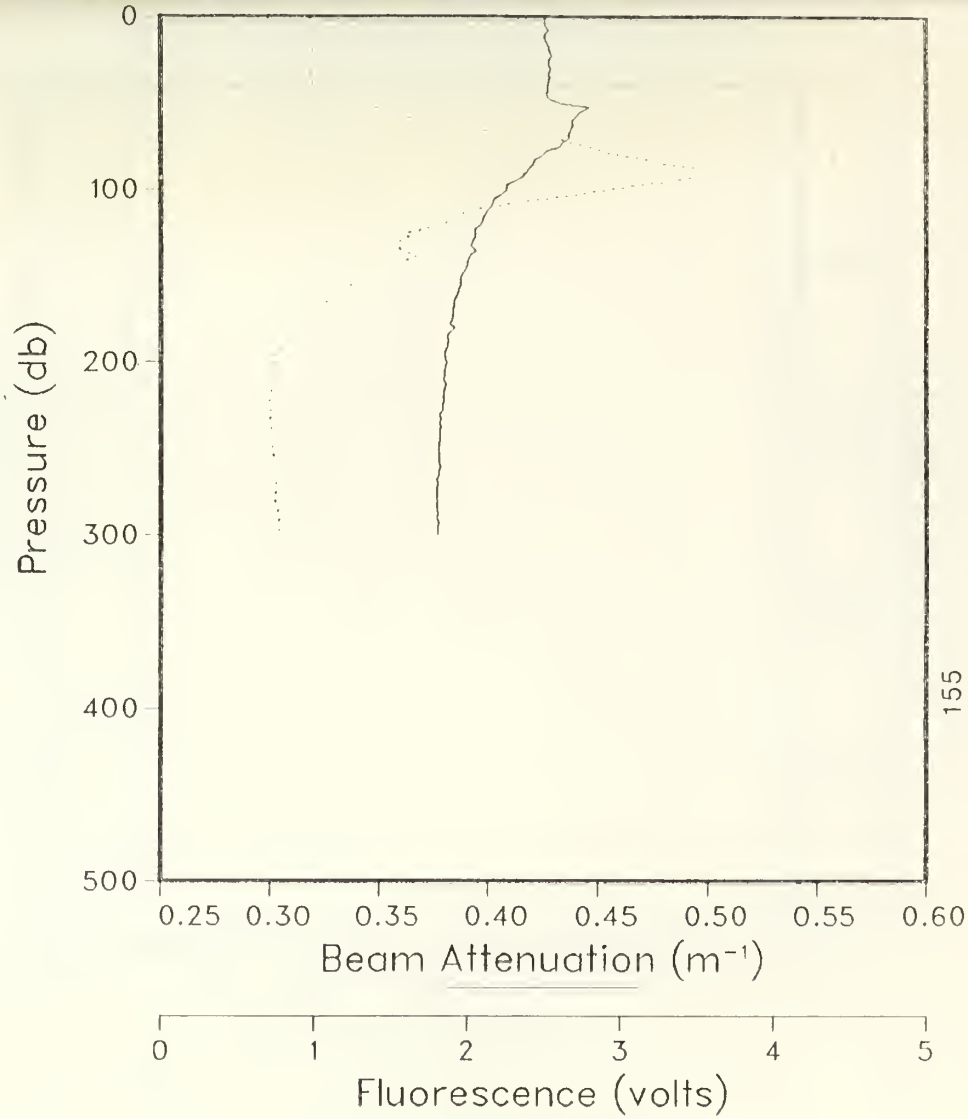


Latitude: 33.825°
Longitude: 141.250°

Date: 11/4/82
Time: 2331:50 GMT

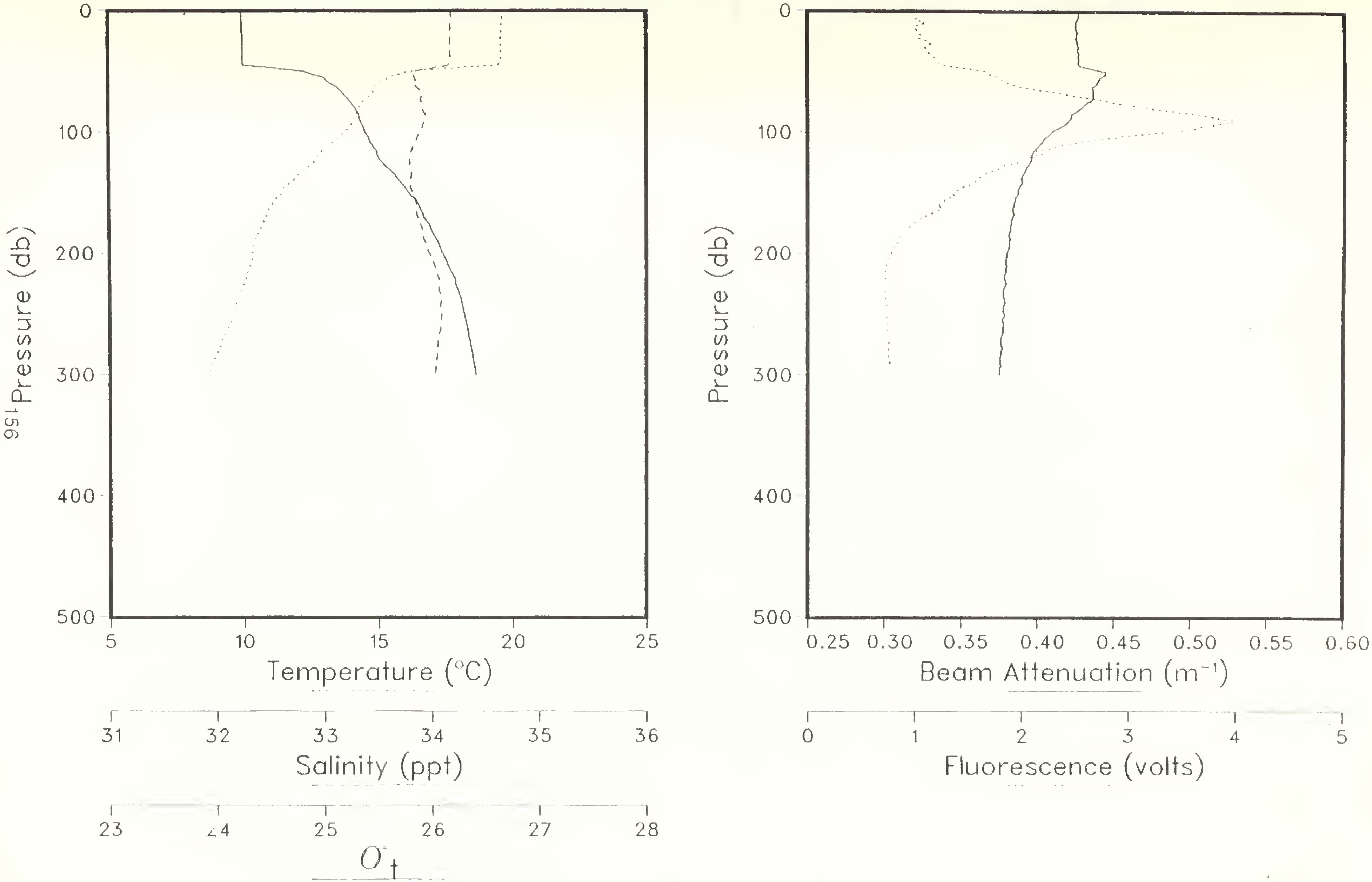
R/V ACANIA CRUISE ODEX3 STATION 95





Latitude: 33.678° Date: 11/5/82
Longitude: 141.258° Time: 156:31 GMT

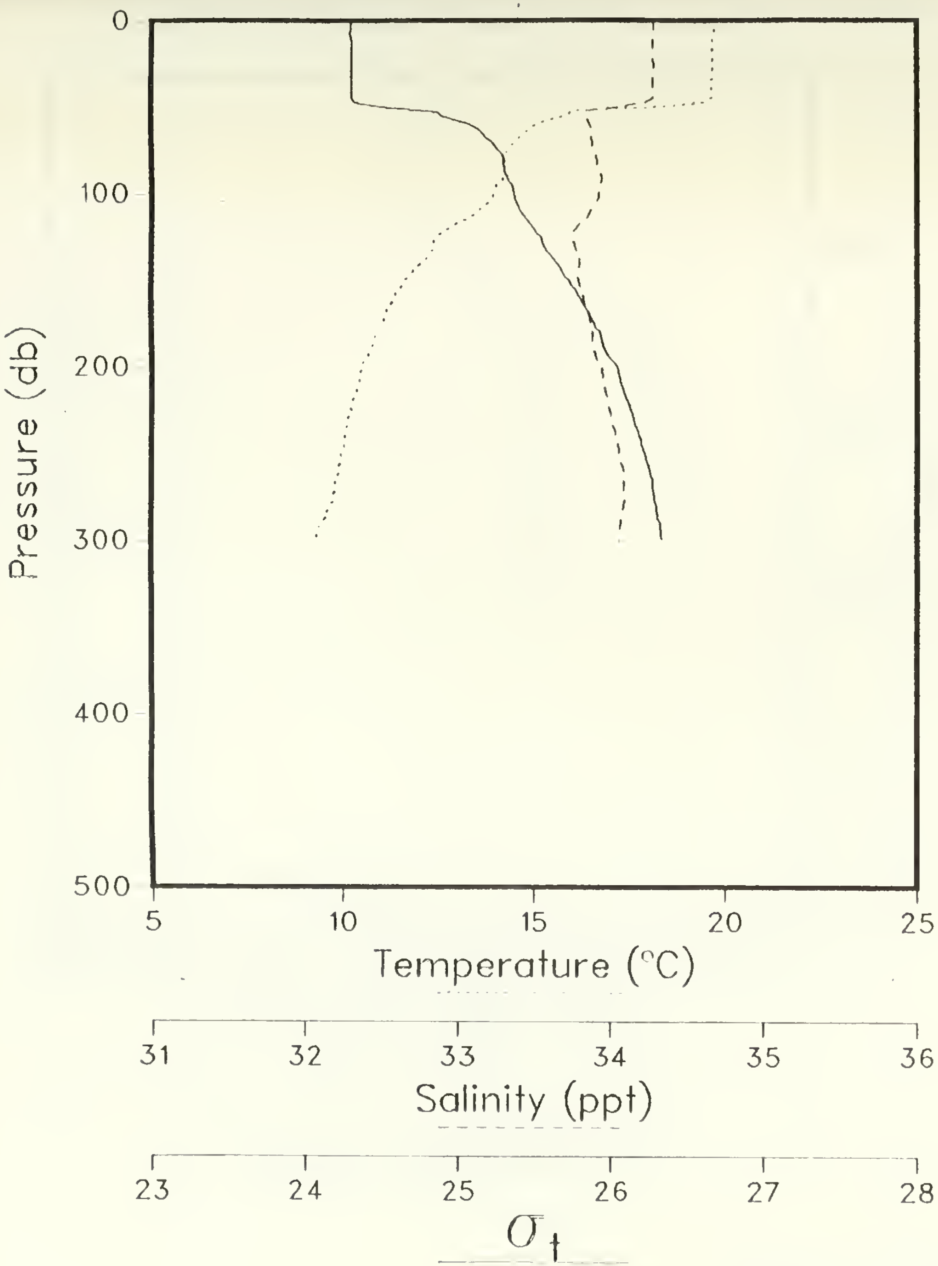
R/V ACANIA CRUISE ODEX3 STATION 96

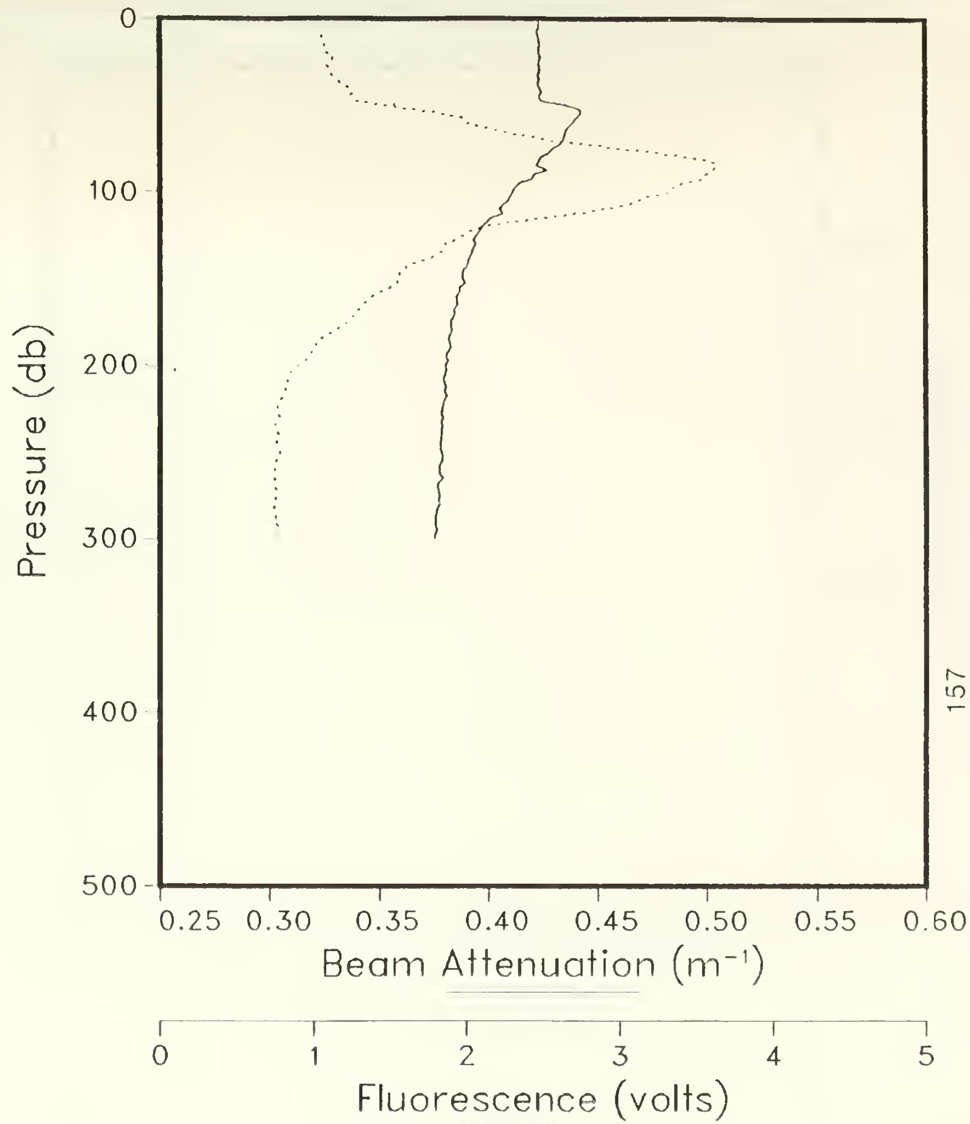


Latitude: 33.578°
Longitude: 141.258°

Date: 11/5/82
Time: 325:12 GMT

R/V ACANIA CRUISE ODEX3 STATION 97

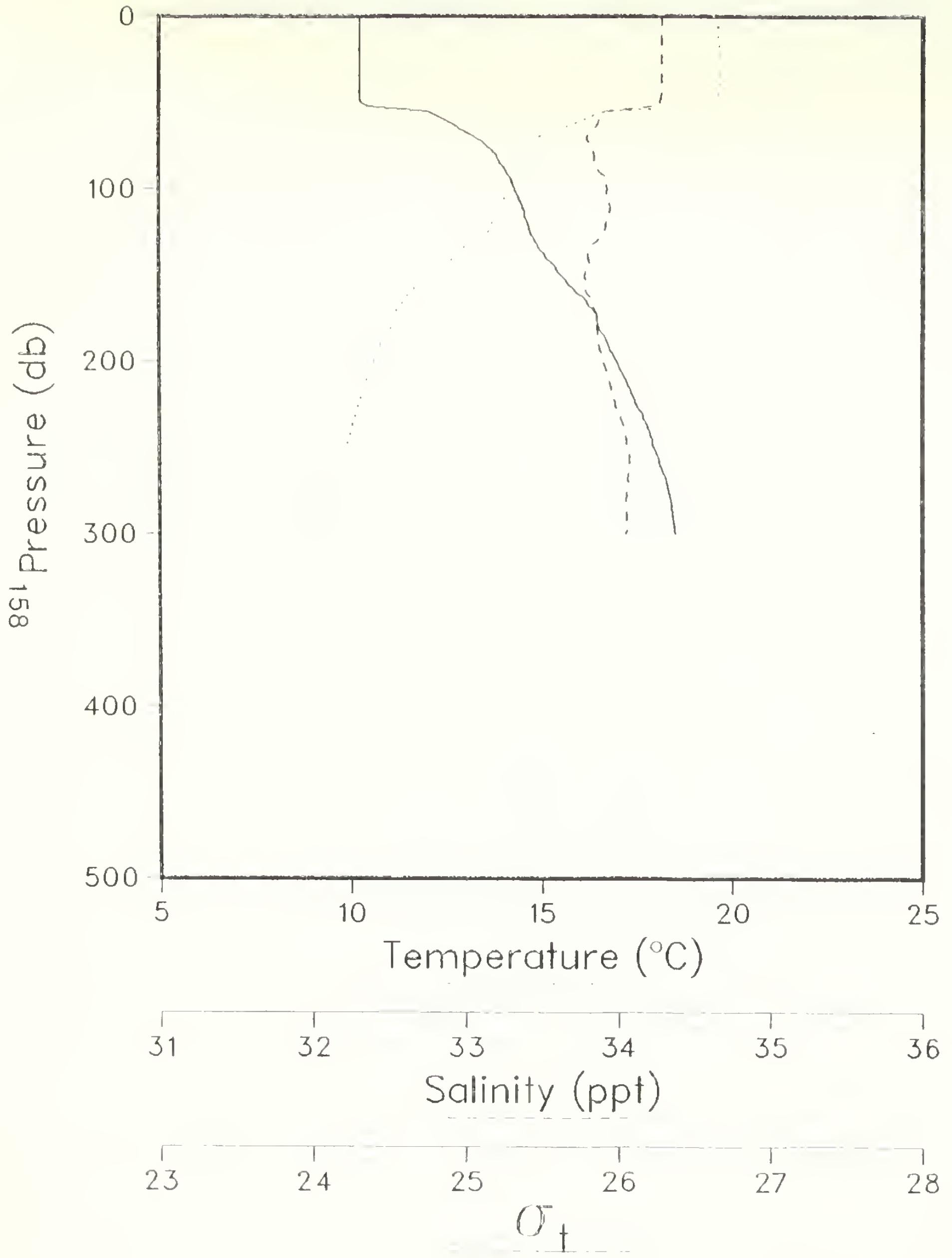


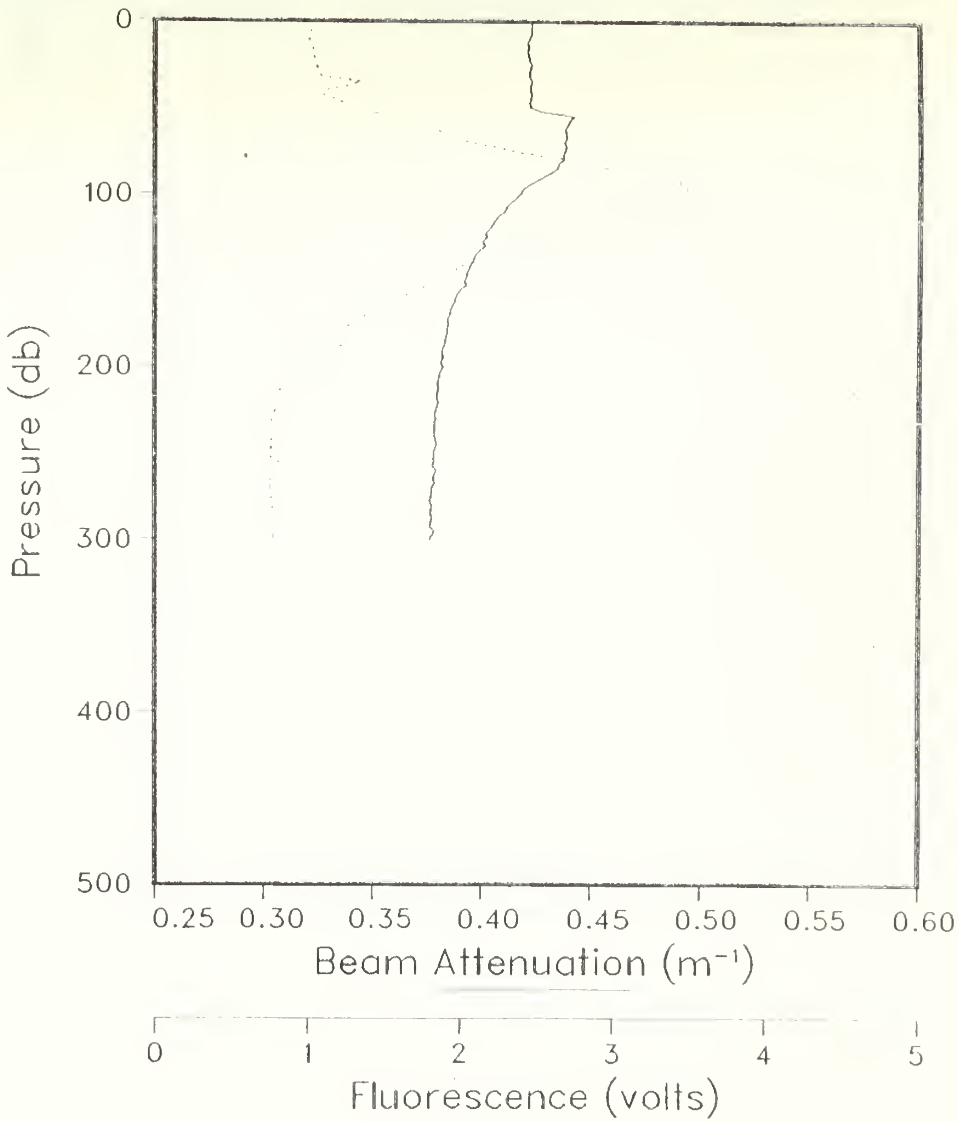


Latitude: 33.467°
Longitude: 141.264°

Date: 11/5/82
Time: 509:06 GMT

R/V ACANIA CRUISE ODEX3 STATION 98

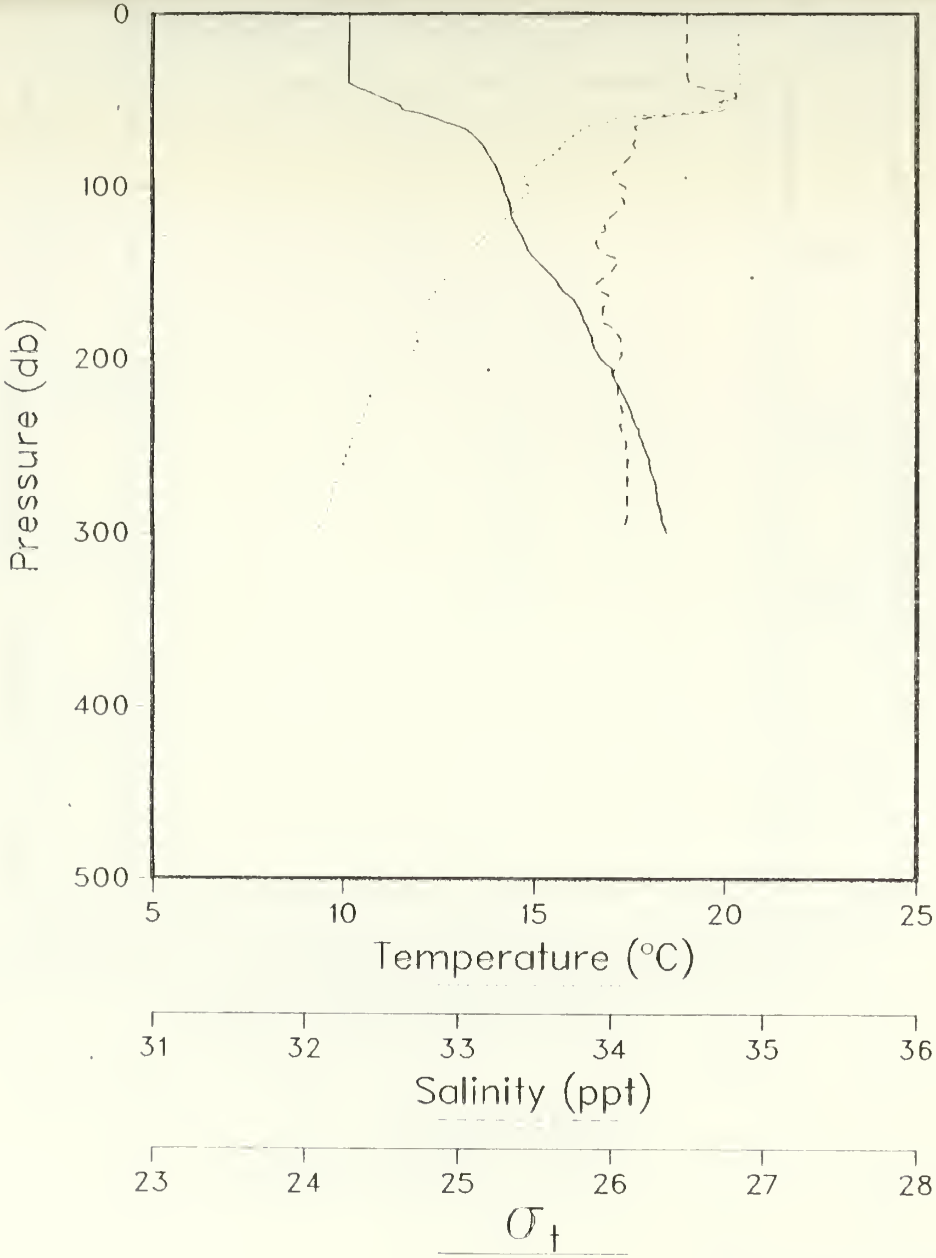


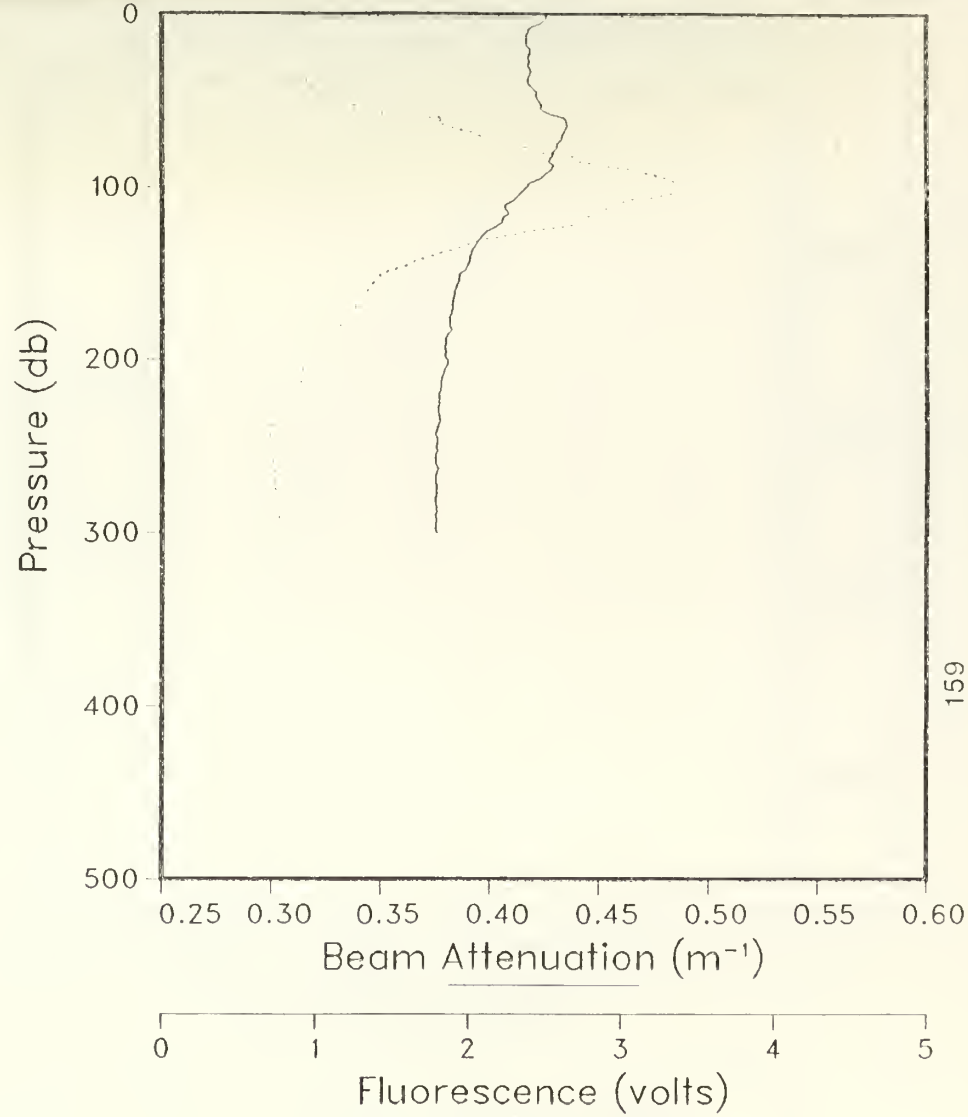


Latitude: 33.380°
Longitude: 141.285°

Date: 11/5/82
Time: 634:31 GMT

R/V ACANIA CRUISE ODEX3 STATION 99

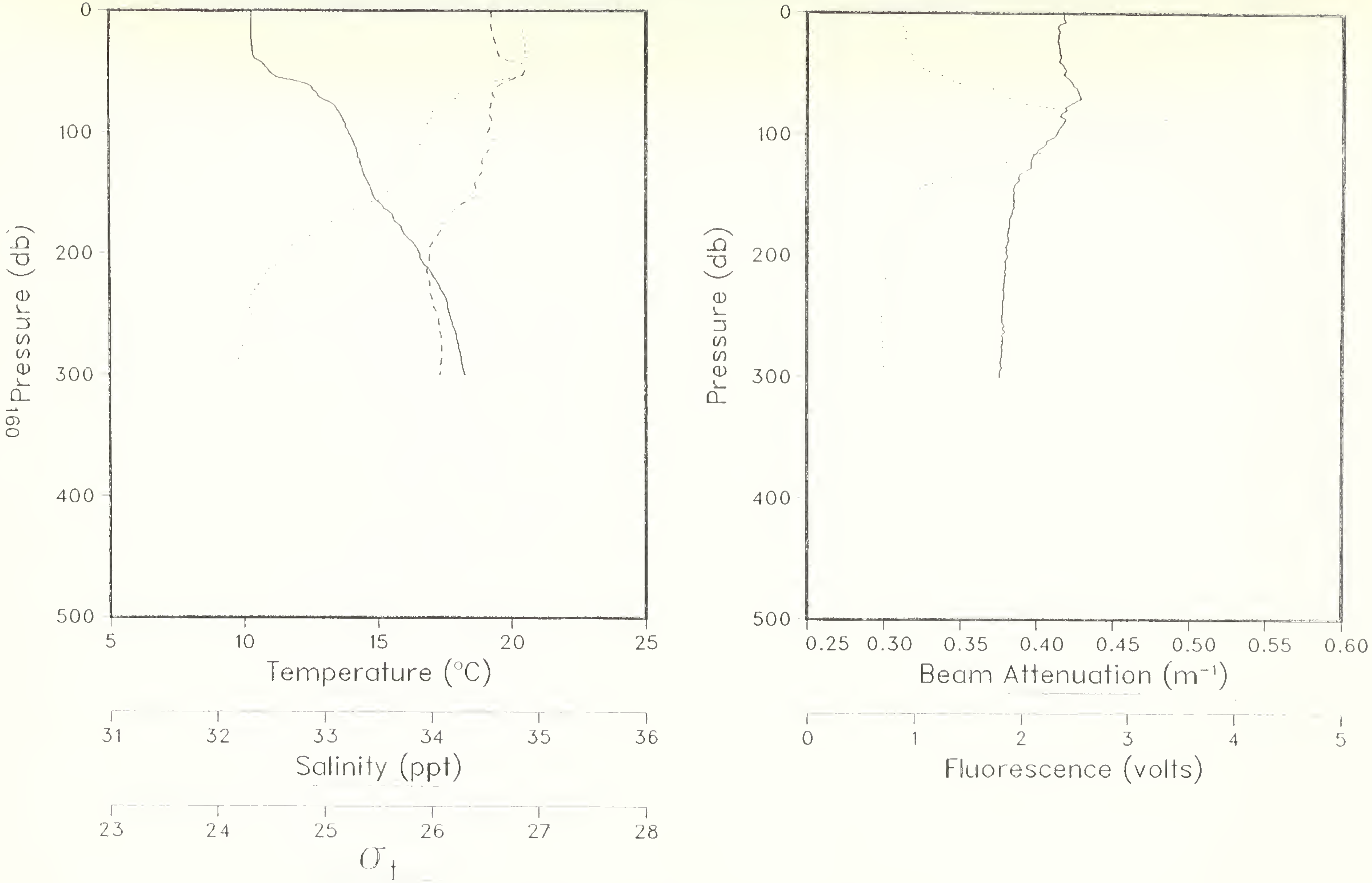




Latitude: 33.280°
Longitude: 141.193°

Date: 11/5/82
Time: 817:43 GMT

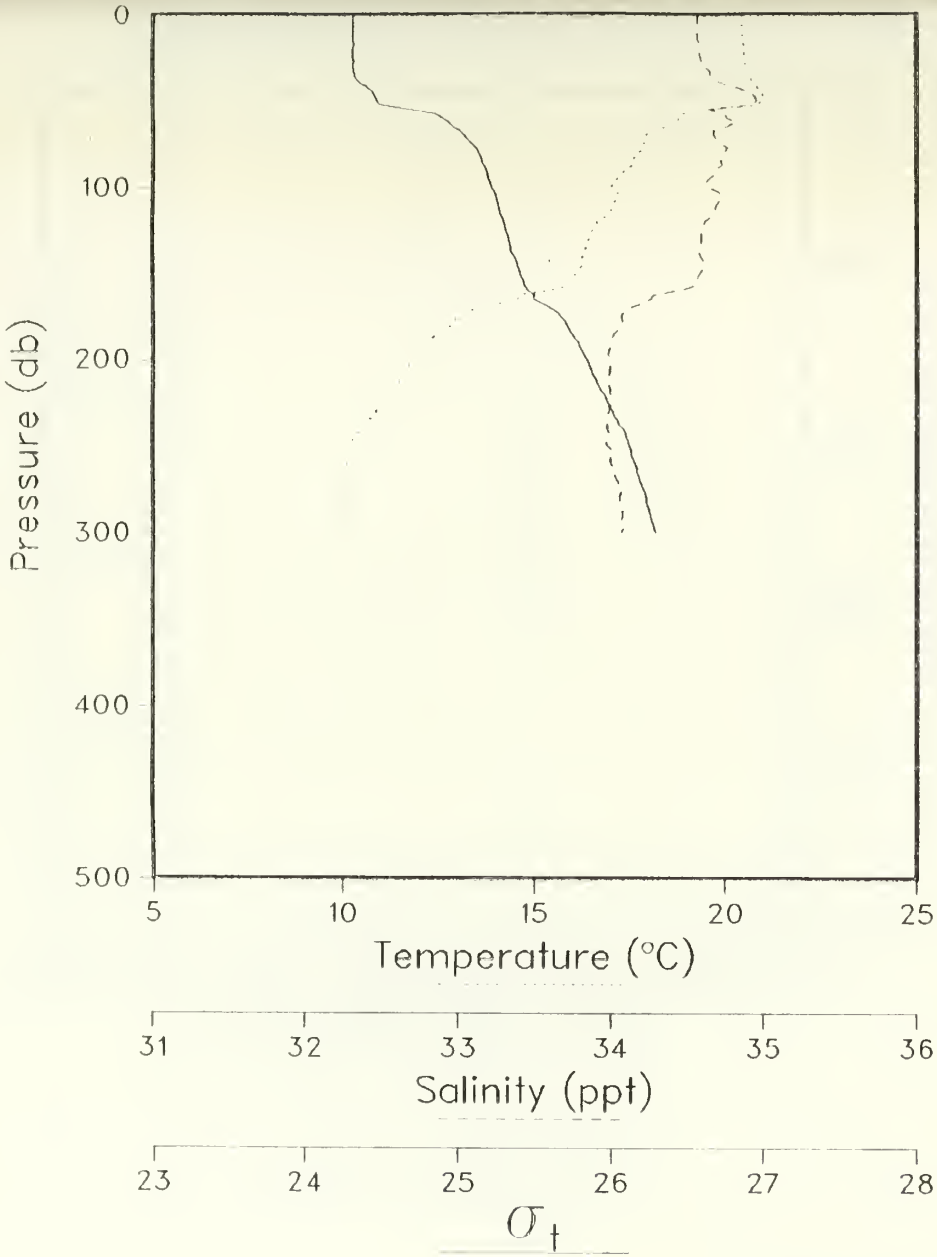
R/V ACANIA CRUISE ODEX3 STATION 100

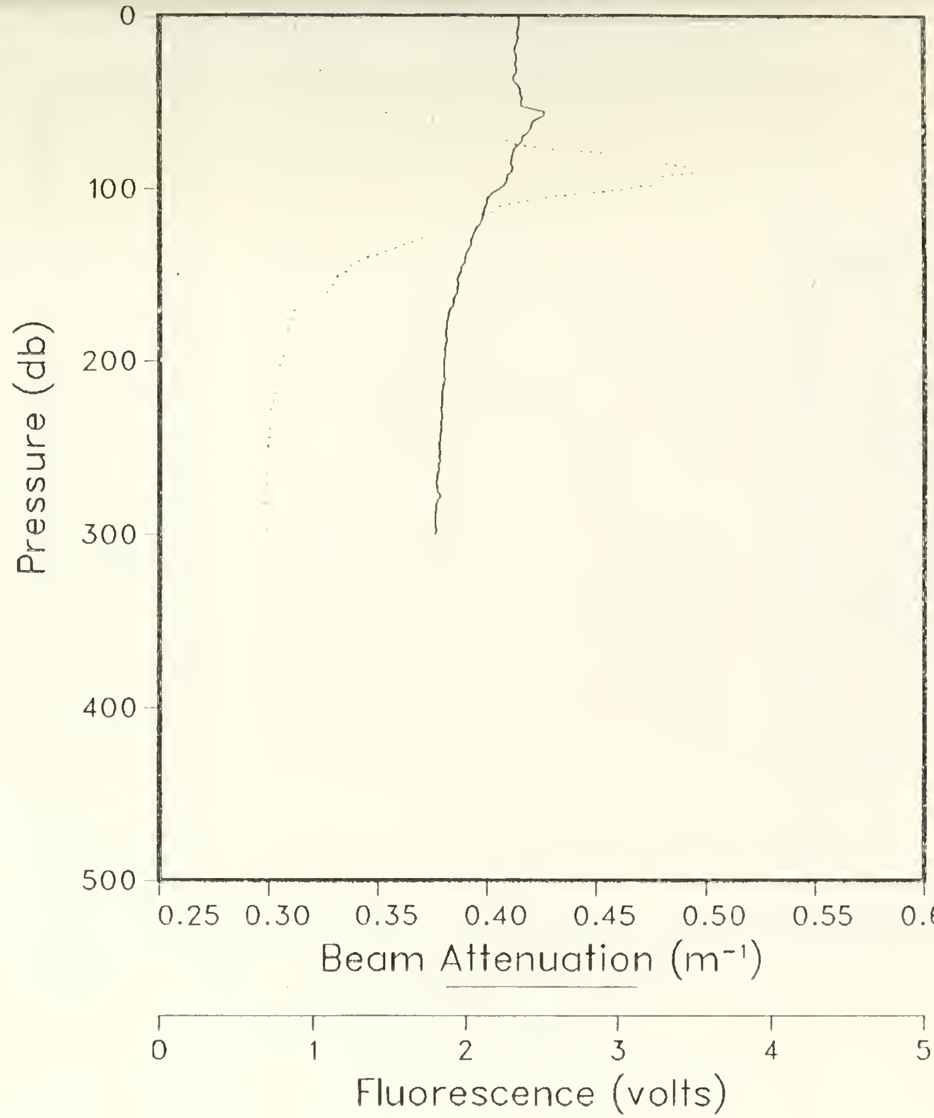


Latitude: 33.123°
Longitude: 141.282°

Date: 11/5/82
Time: 1032:50 GMT

R/V ACANIA CRUISE ODEX3 STATION 101

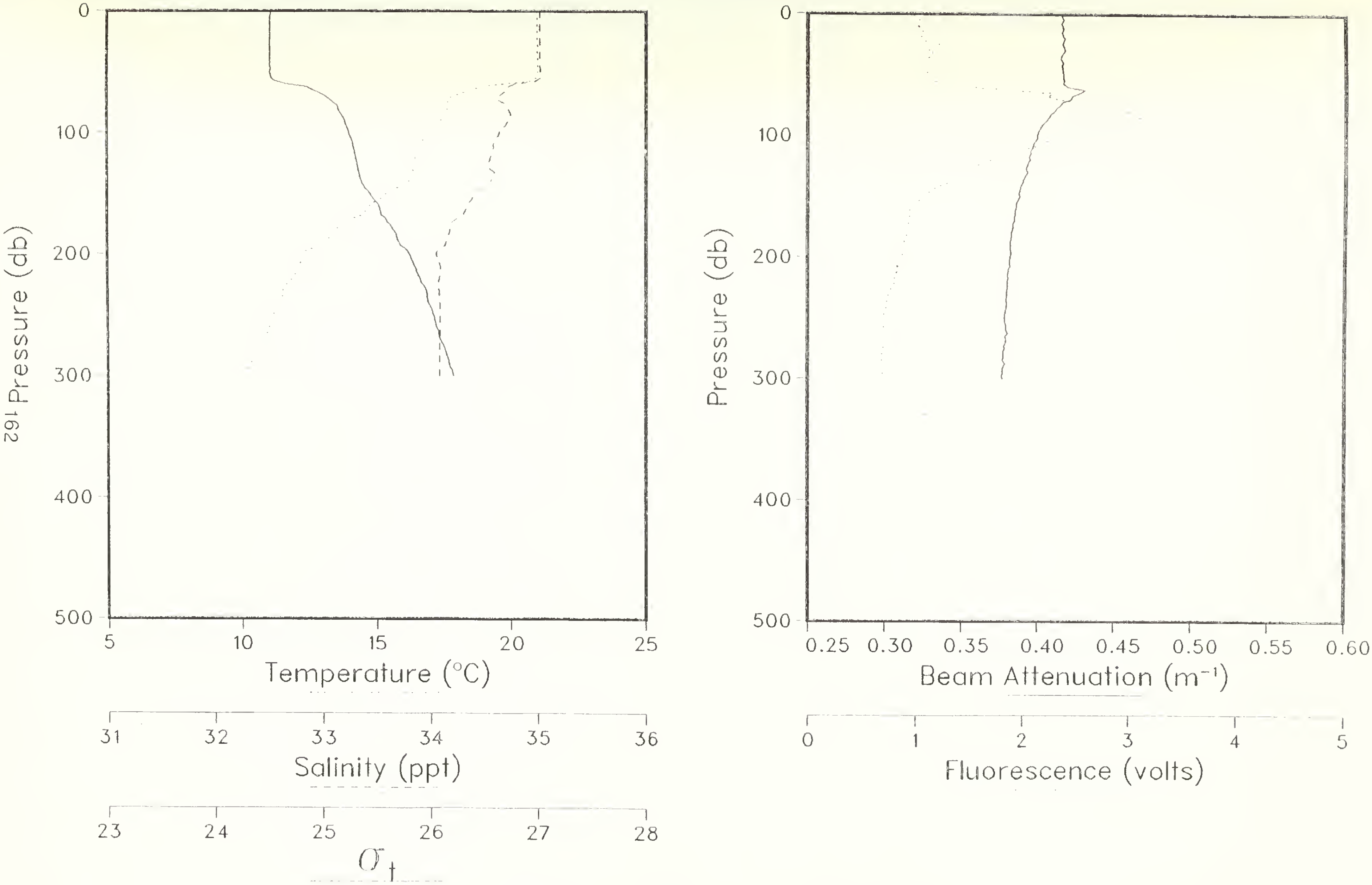




Latitude: 33.012°
Longitude: 141.213°

Date: 11/5/82
Time: 1222:16 GMT

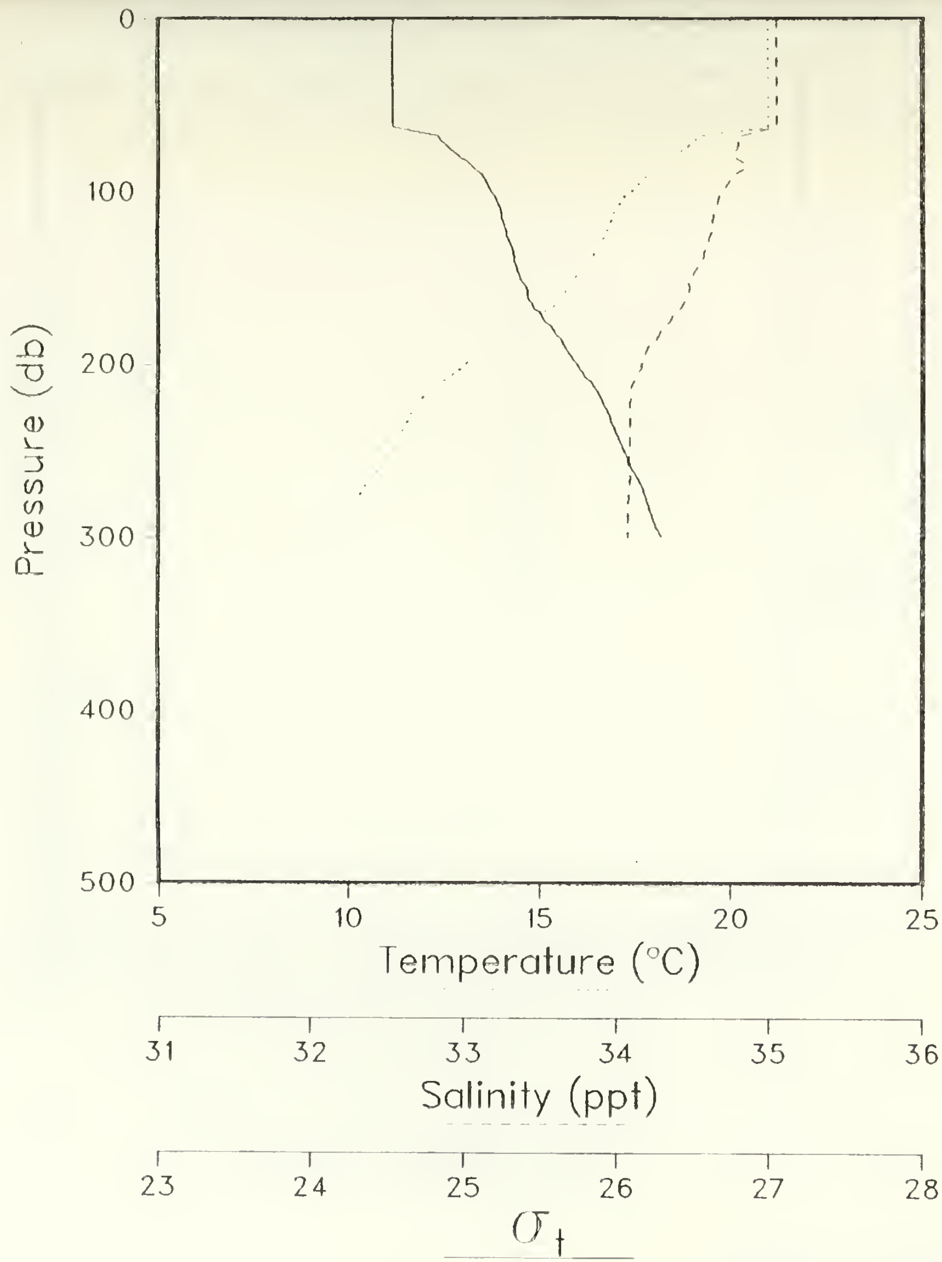
R/V ACANIA CRUISE ODEX3 STATION 102

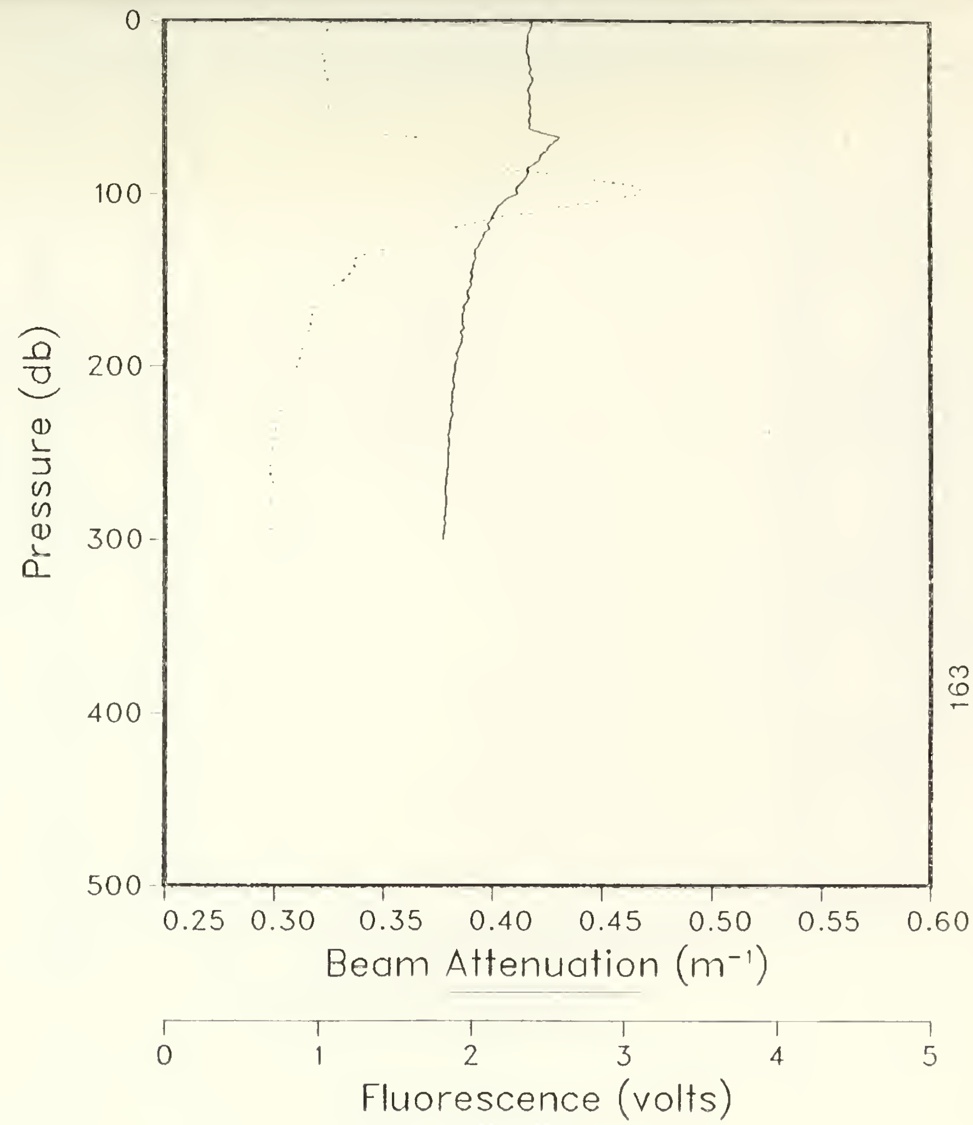


Latitude: 32.885°
Longitude: 141.286°

Date: 11/5/82
Time: 1419:14 GMT

R/V ACANIA CRUISE ODEX3 STATION 103

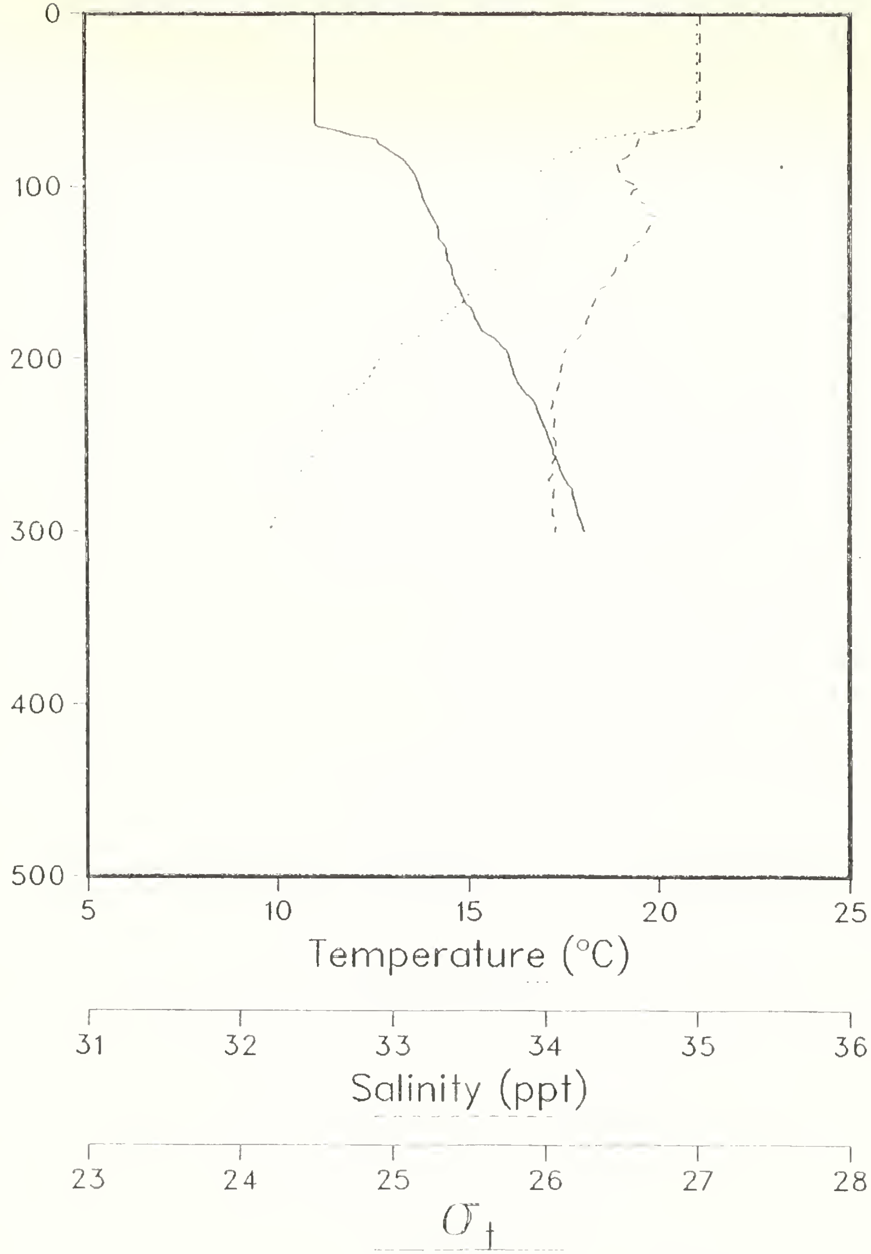


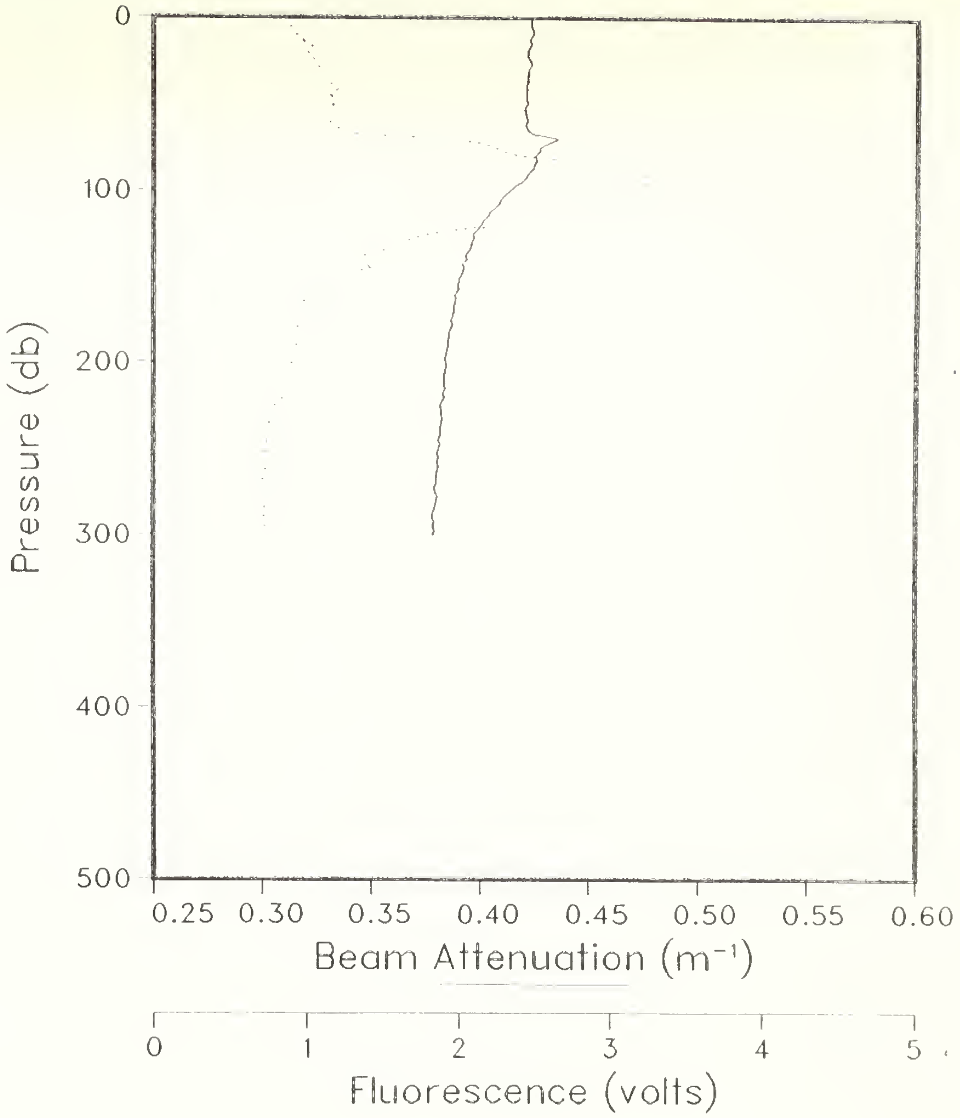


Latitude: 32.778°
Longitude: 141.260°

Date: 11/5/82
Time: 1614:08 GMT

R/V ACANIA CRUISE ODEX3 STATION 104

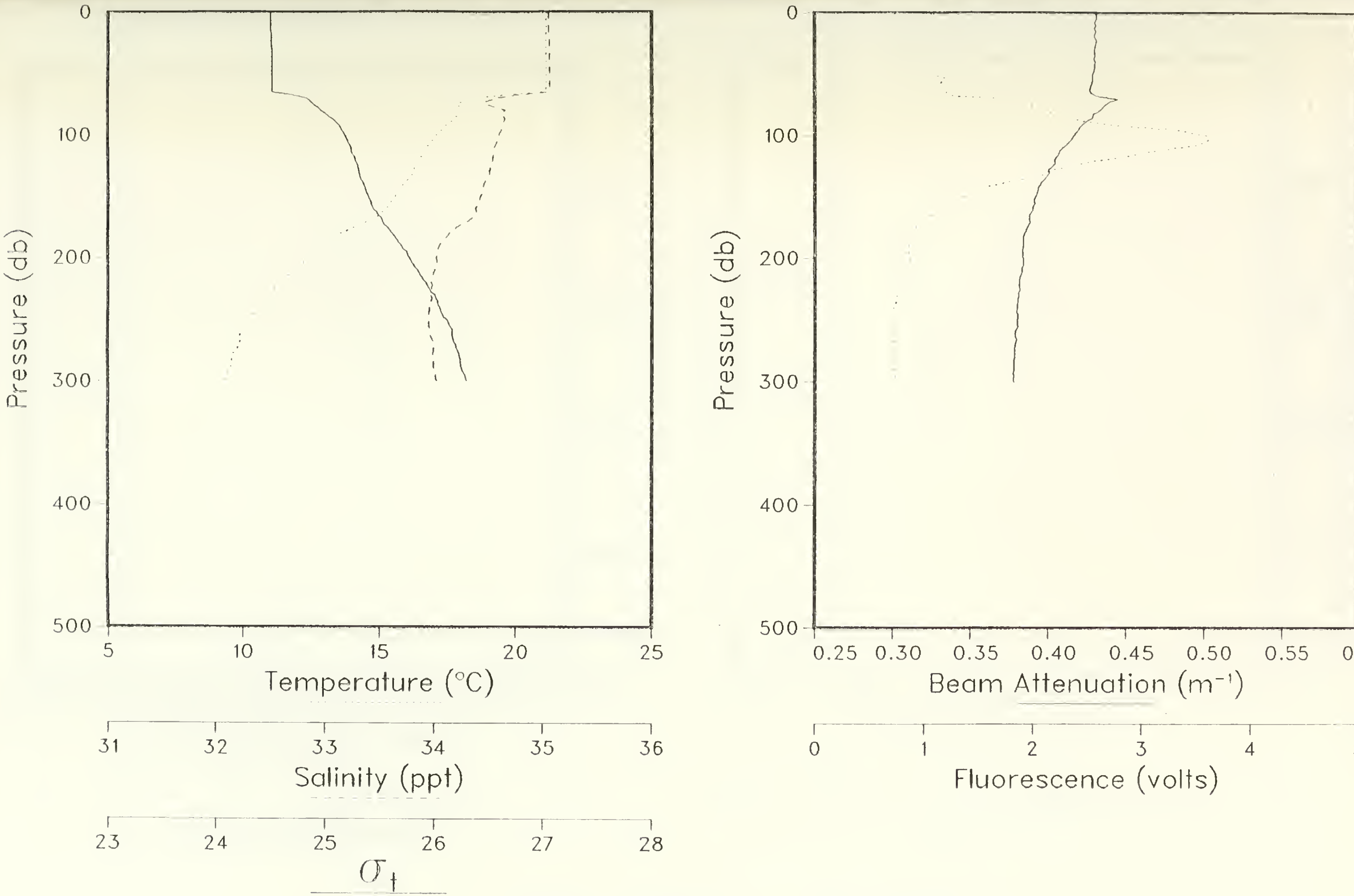




Latitude: 32.804°
Longitude: 141.350°

Date: 11/5/82
Time: 1833:22 GMT

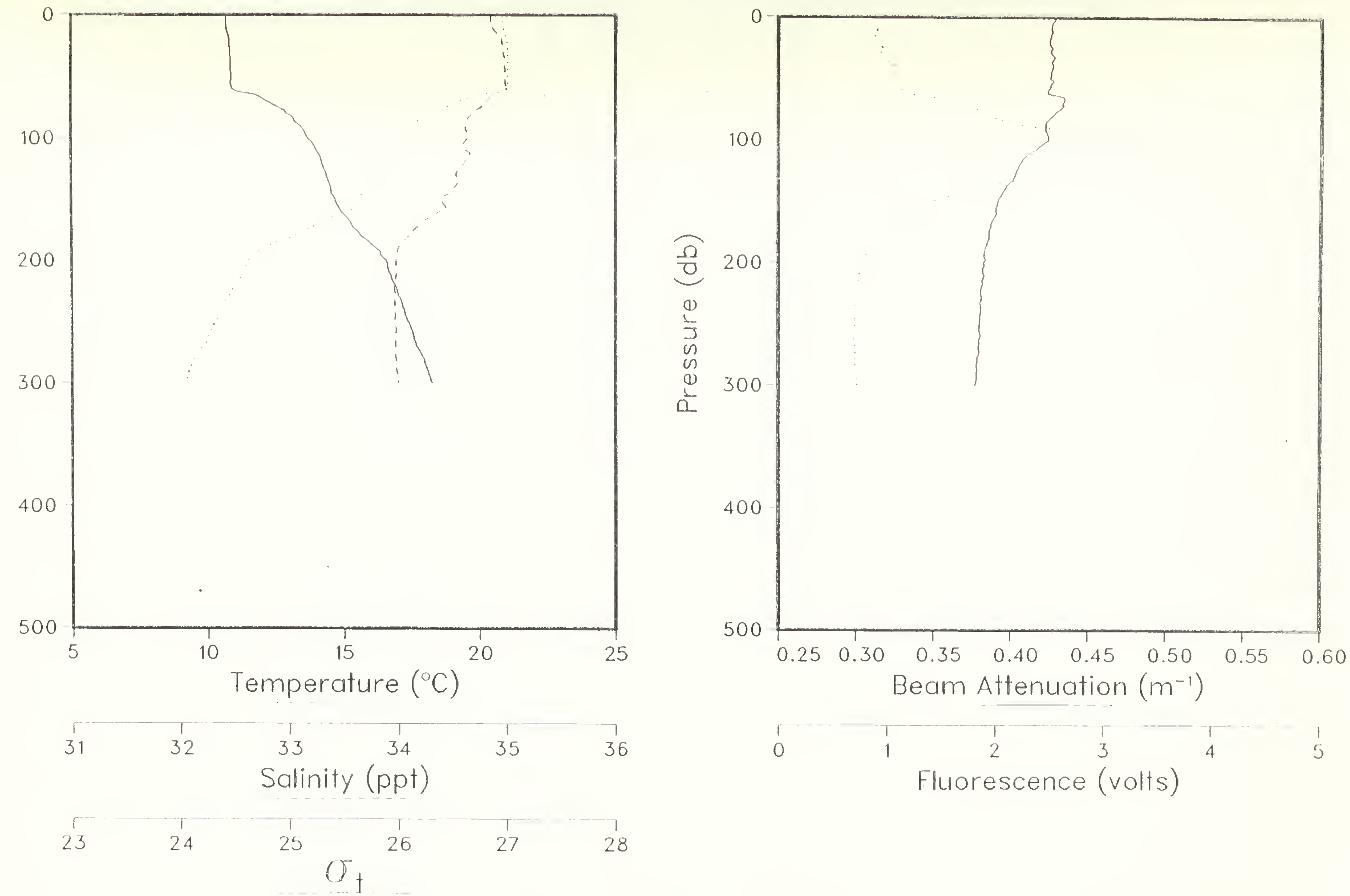
R/V ACANIA CRUISE ODEX3 STATION 105



Latitude: 32.775°
Longitude: 141.532°

Date: 11/5/82
Time: 2236:57 GMT

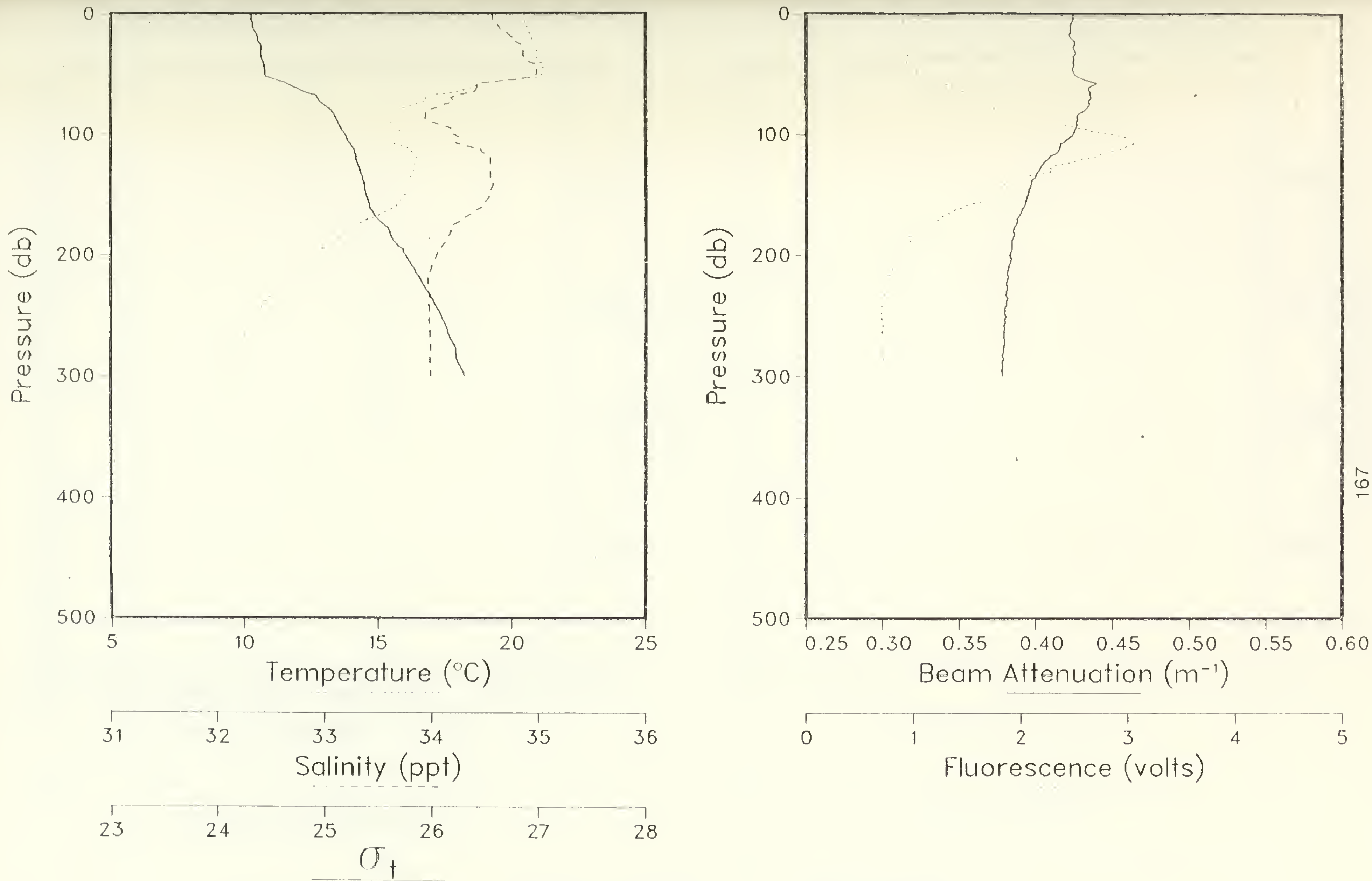
R/V ACANIA CRUISE ODEX3 STATION 106



Latitude: 32.768°
Longitude: 141.682°

Date: 11/6/82
Time: 56:05 GMT

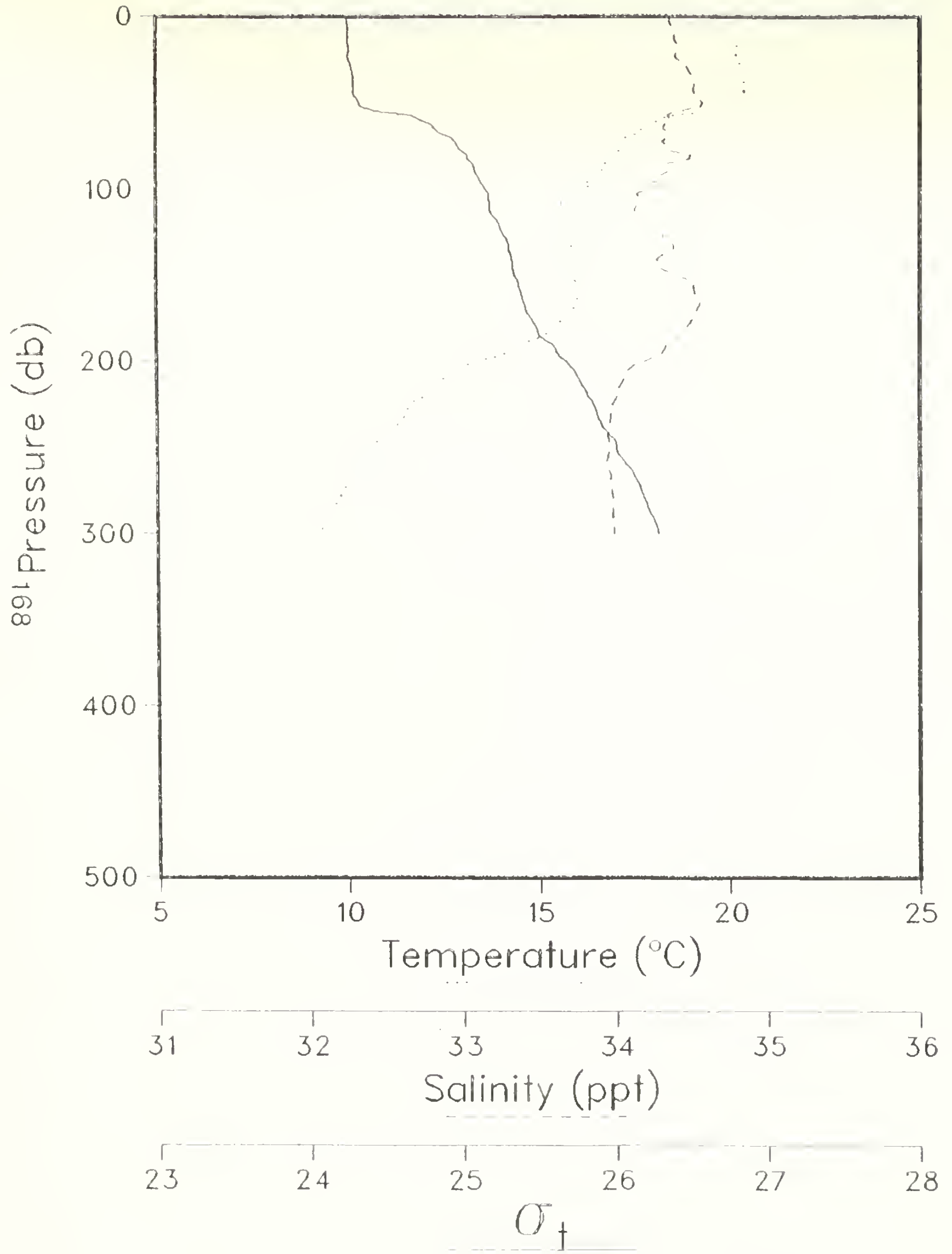
R/V ACANIA CRUISE ODEX3 STATION 107

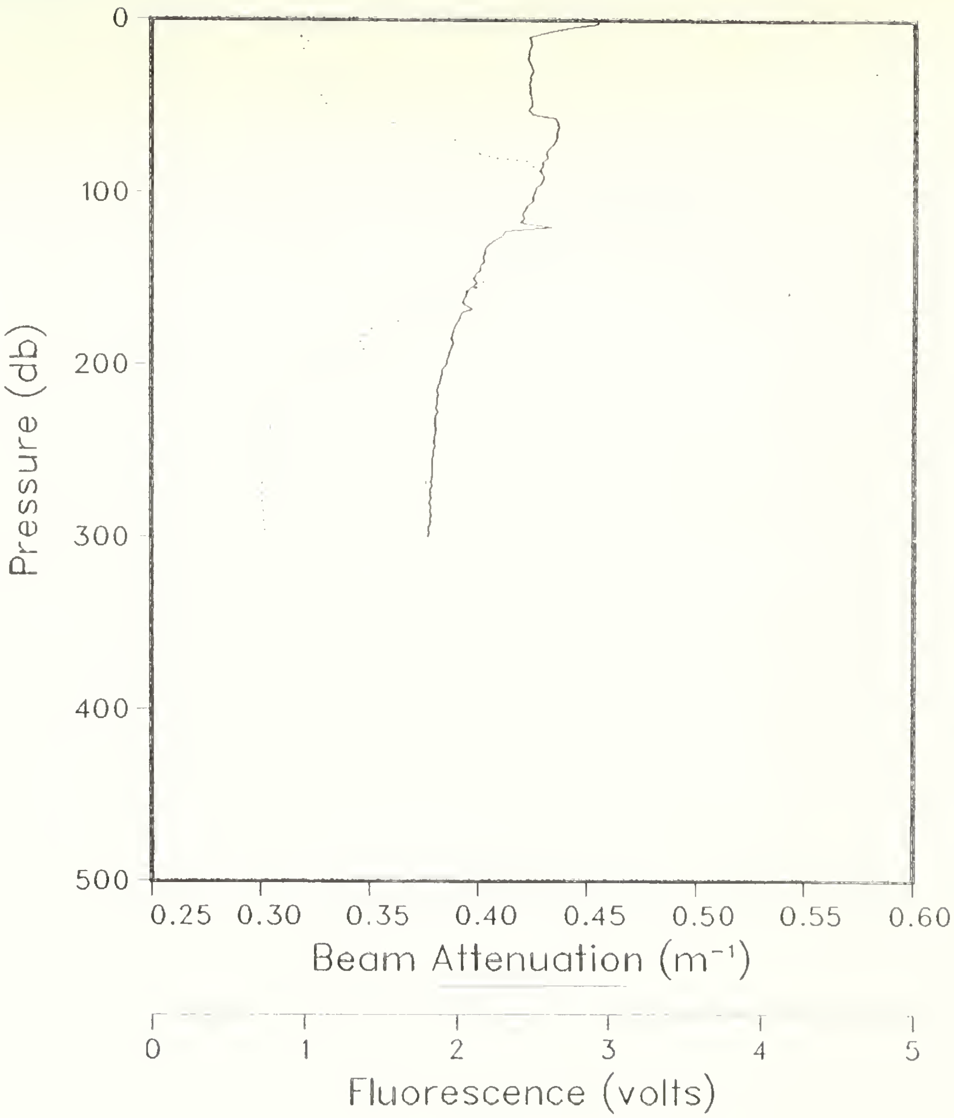


Latitude: 32.650°
Longitude: 141.690°

Date: 11/6/82
Time: 235:00 GMT

R/V ACANIA CRUISE ODEX3 STATION 108

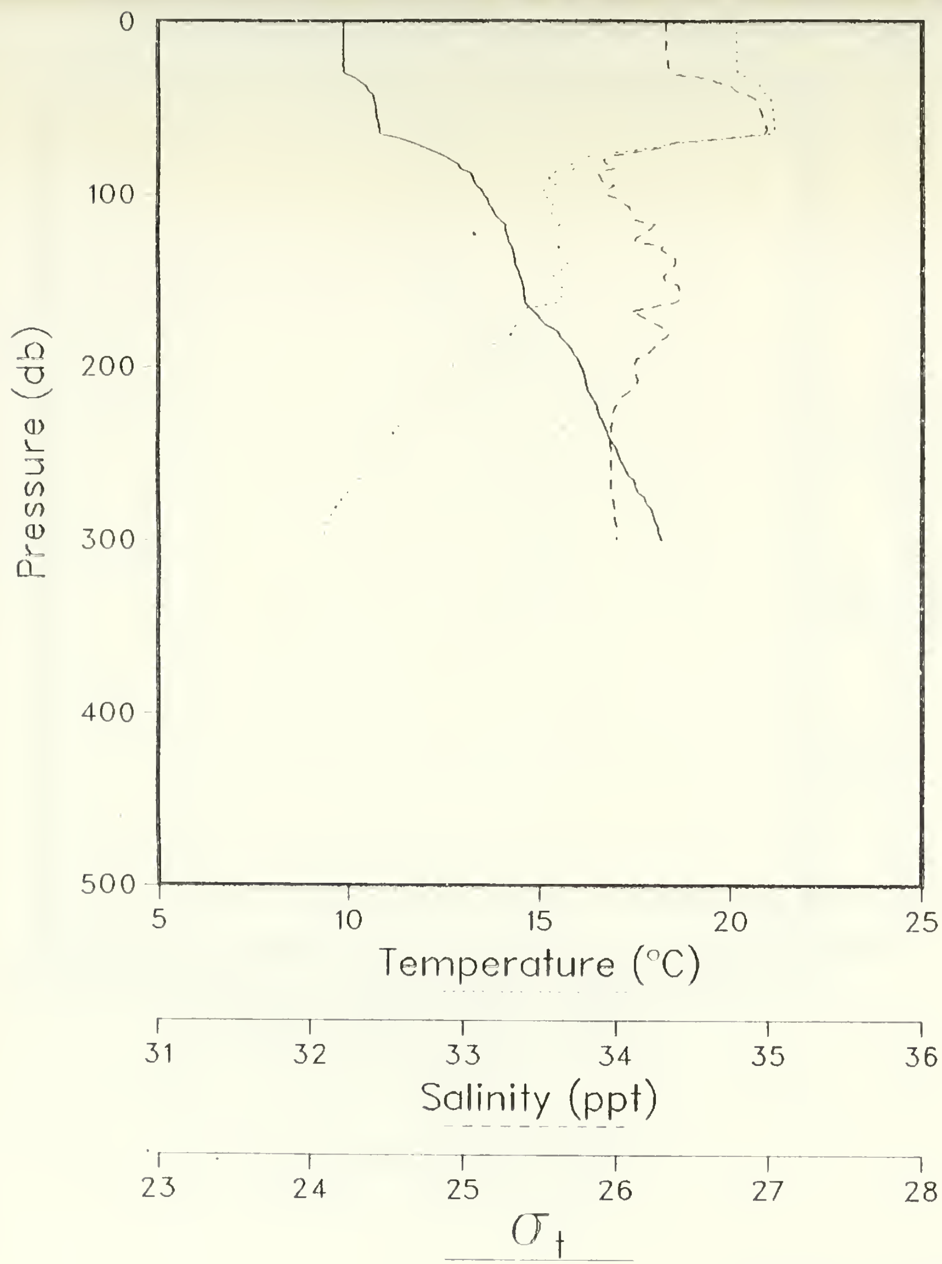


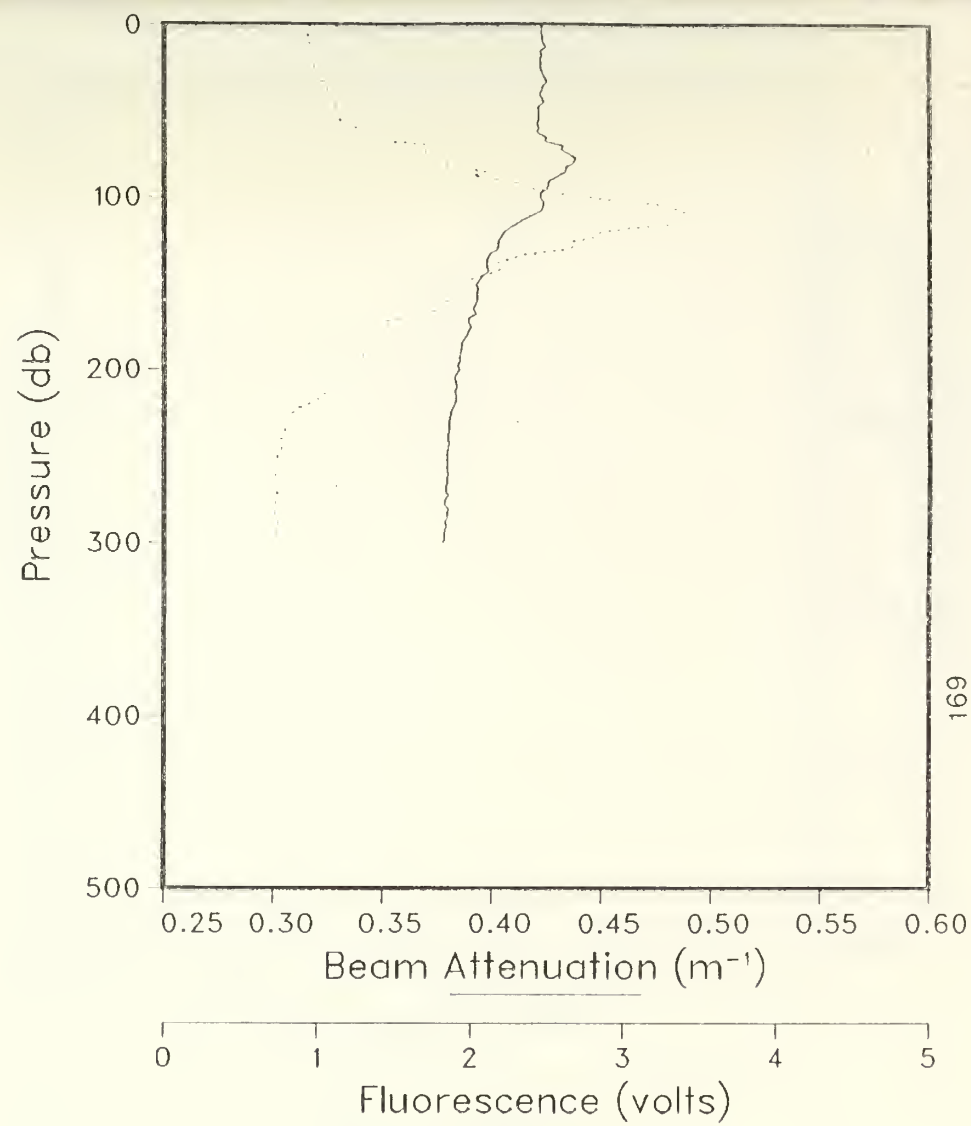


Latitude: 32.533°
Longitude: 141.727°

Date: 11/6/82
Time: 422:15 GMT

R/V ACANIA CRUISE ODEX3 STATION 109

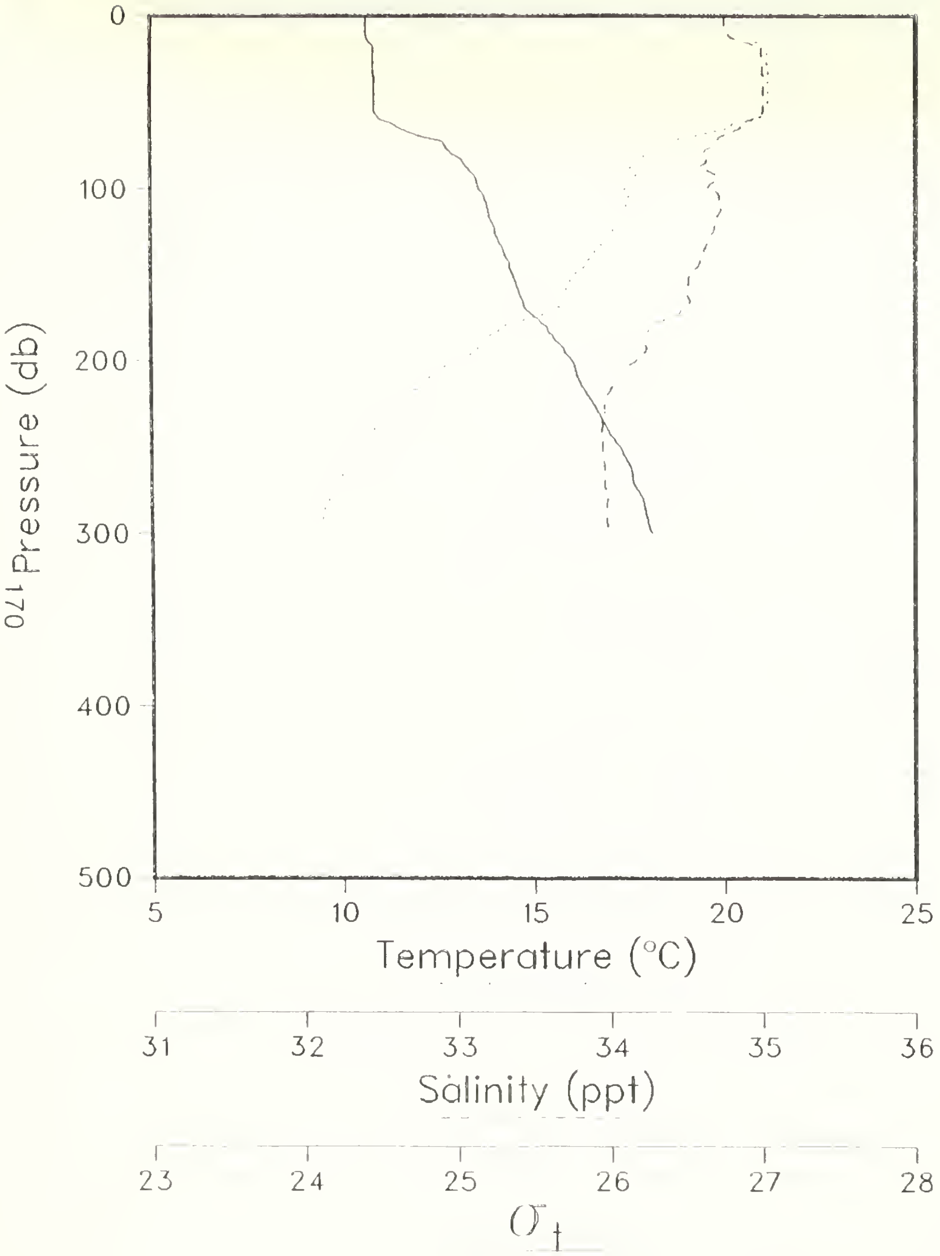


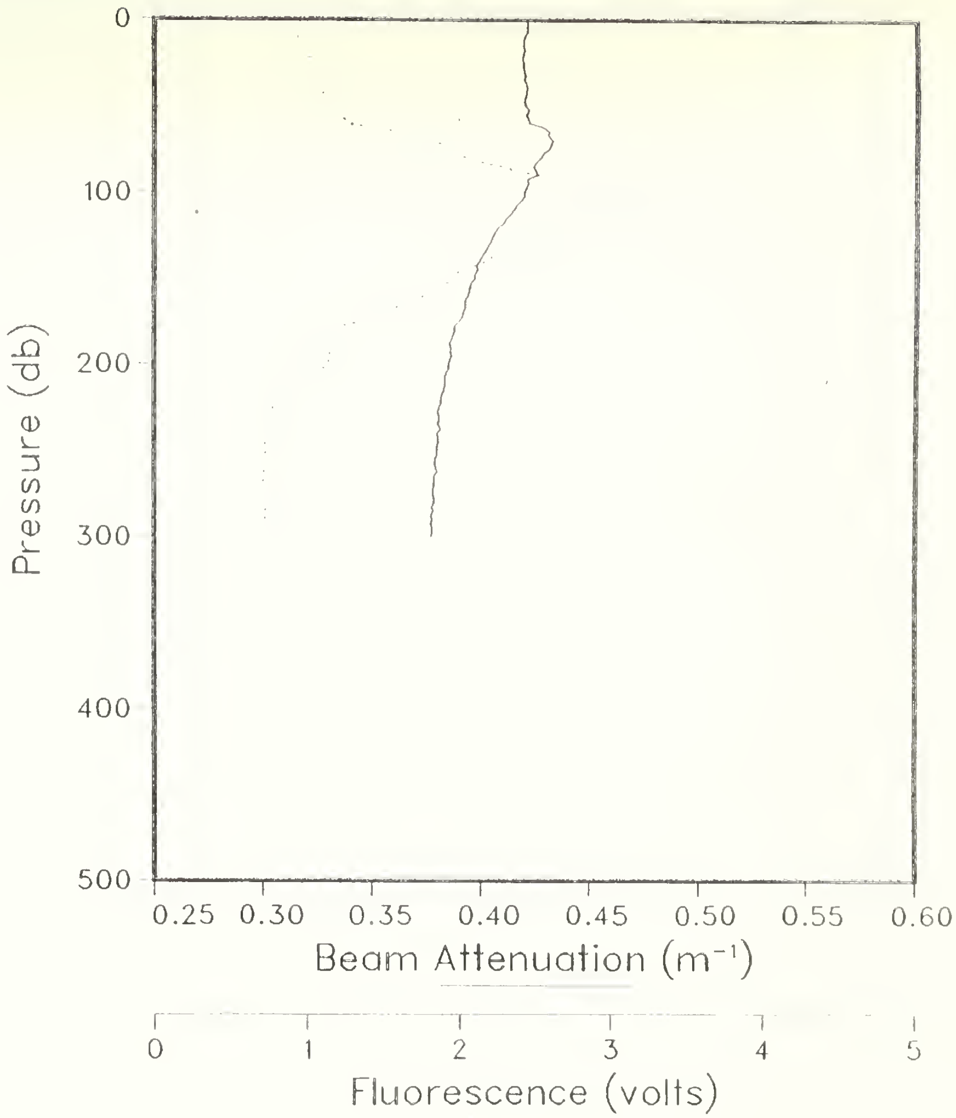


Latitude: 32.398°
Longitude: 141.711°

Date: 11/6/82
Time: 603:22 GMT

R/V ACANIA CRUISE ODEX3 STATION 110

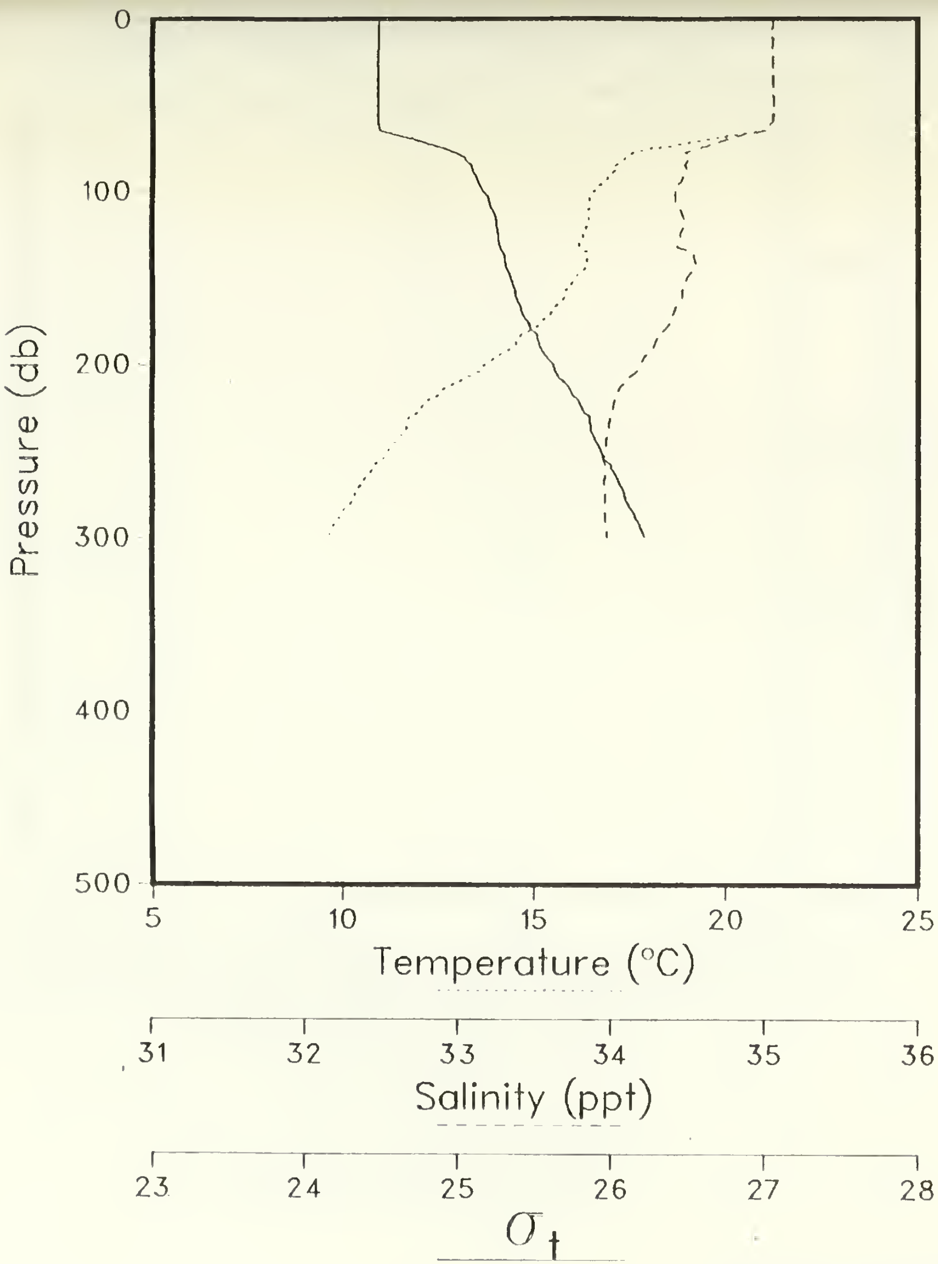


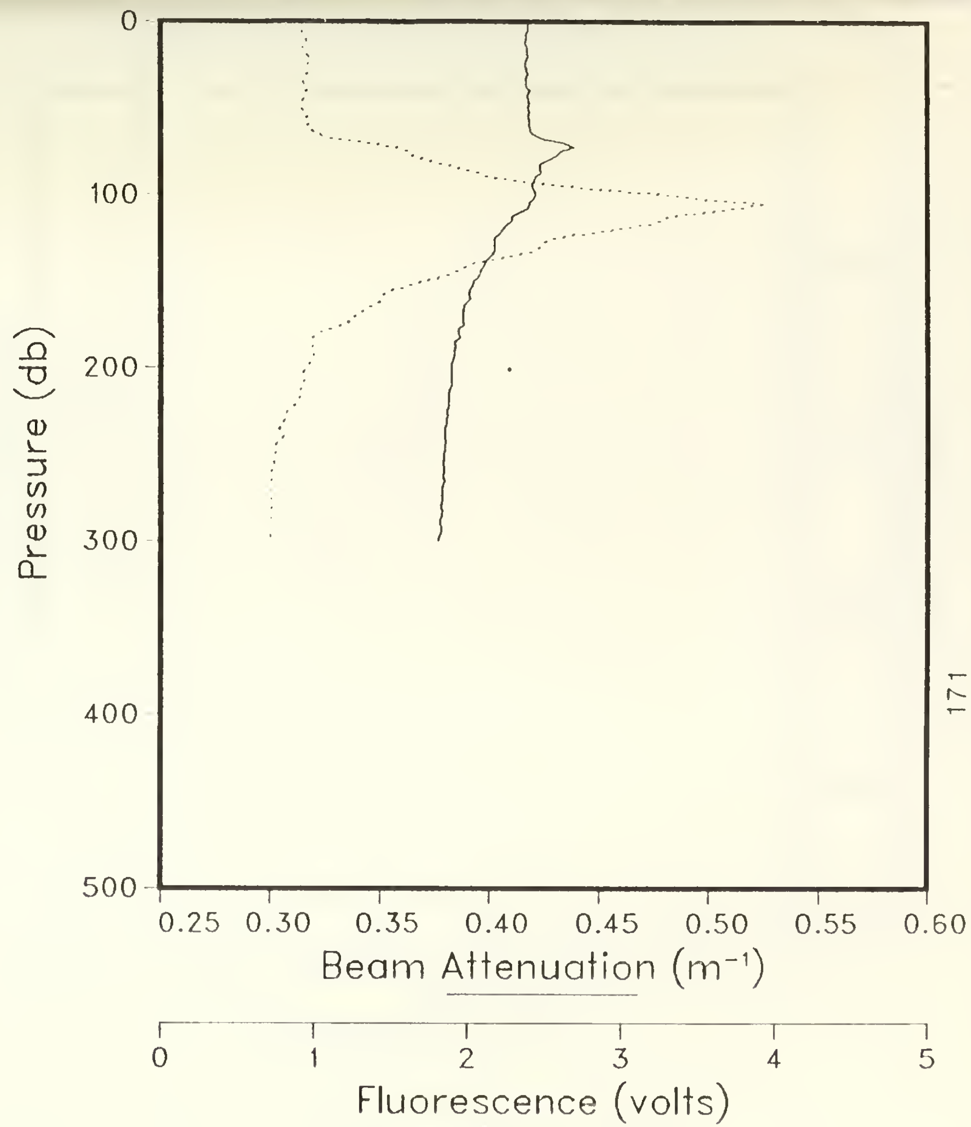


Latitude: 32.303°
Longitude: 141.668°

Date: 11/6/82
Time: 757:25 GMT

R/V ACANIA CRUISE ODEX3 STATION 111

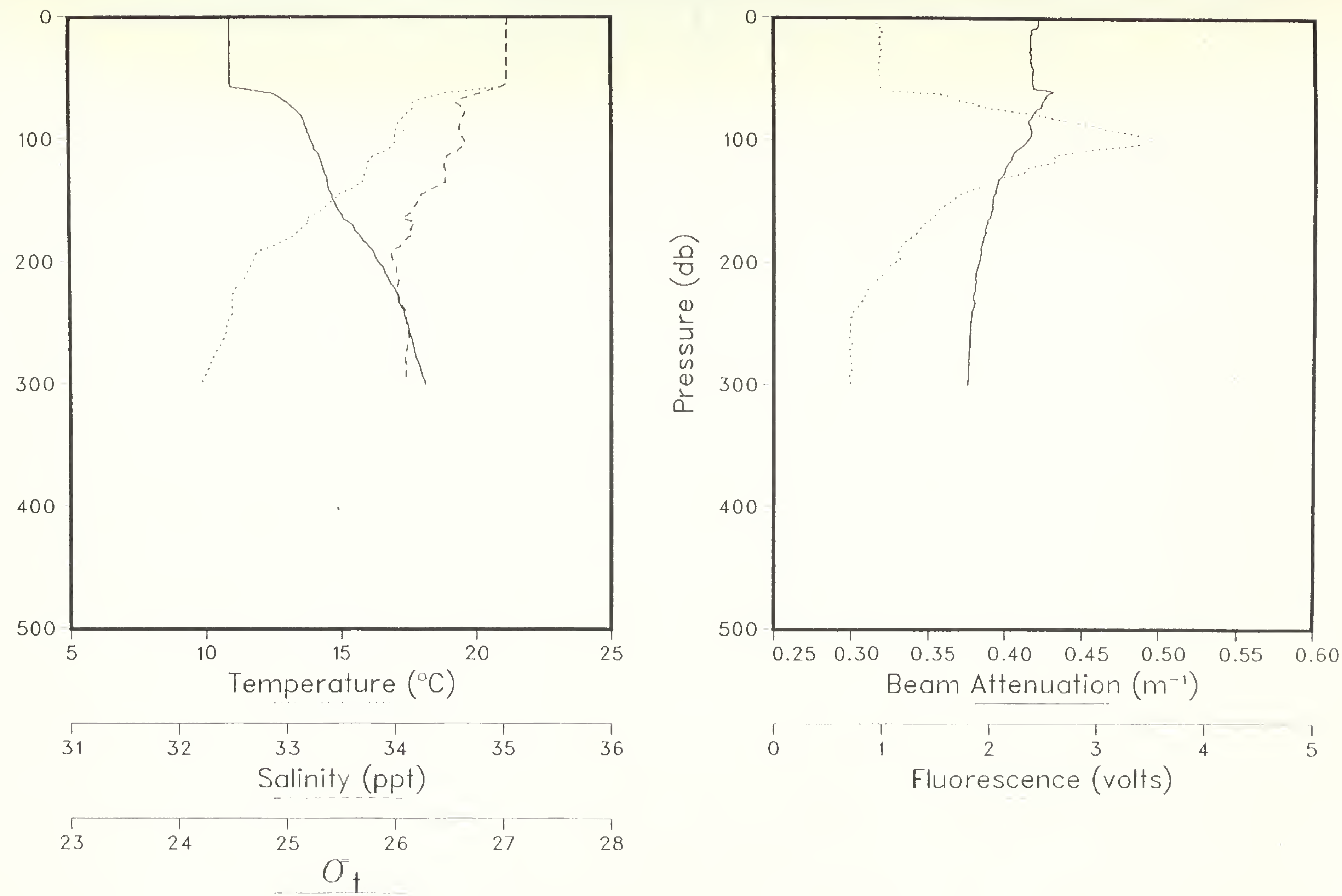




Latitude: 32.167°
Longitude: 141.682°

Date: 11/6/82
Time: 952:44 GMT

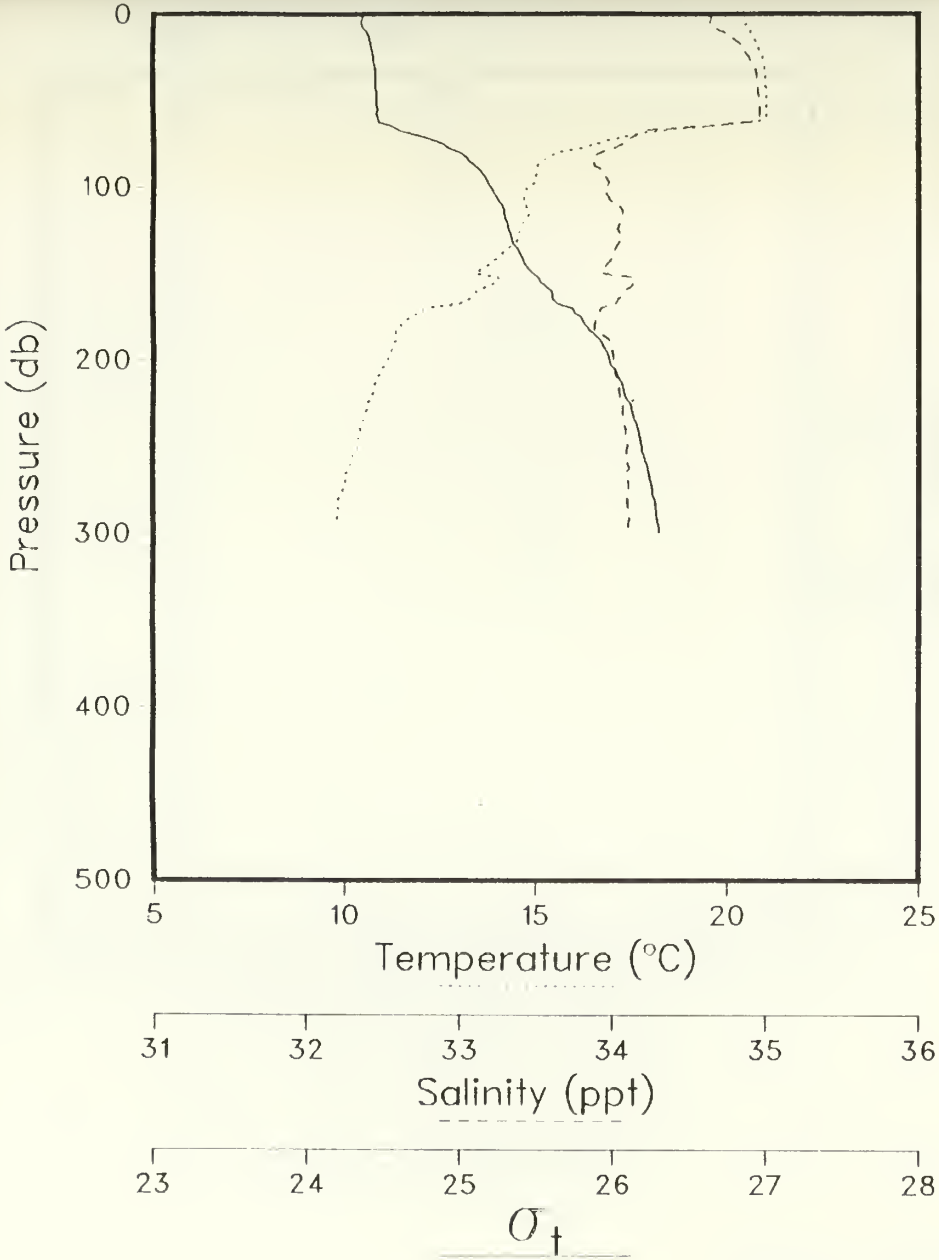
R/V ACANIA CRUISE ODEX3 STATION 112

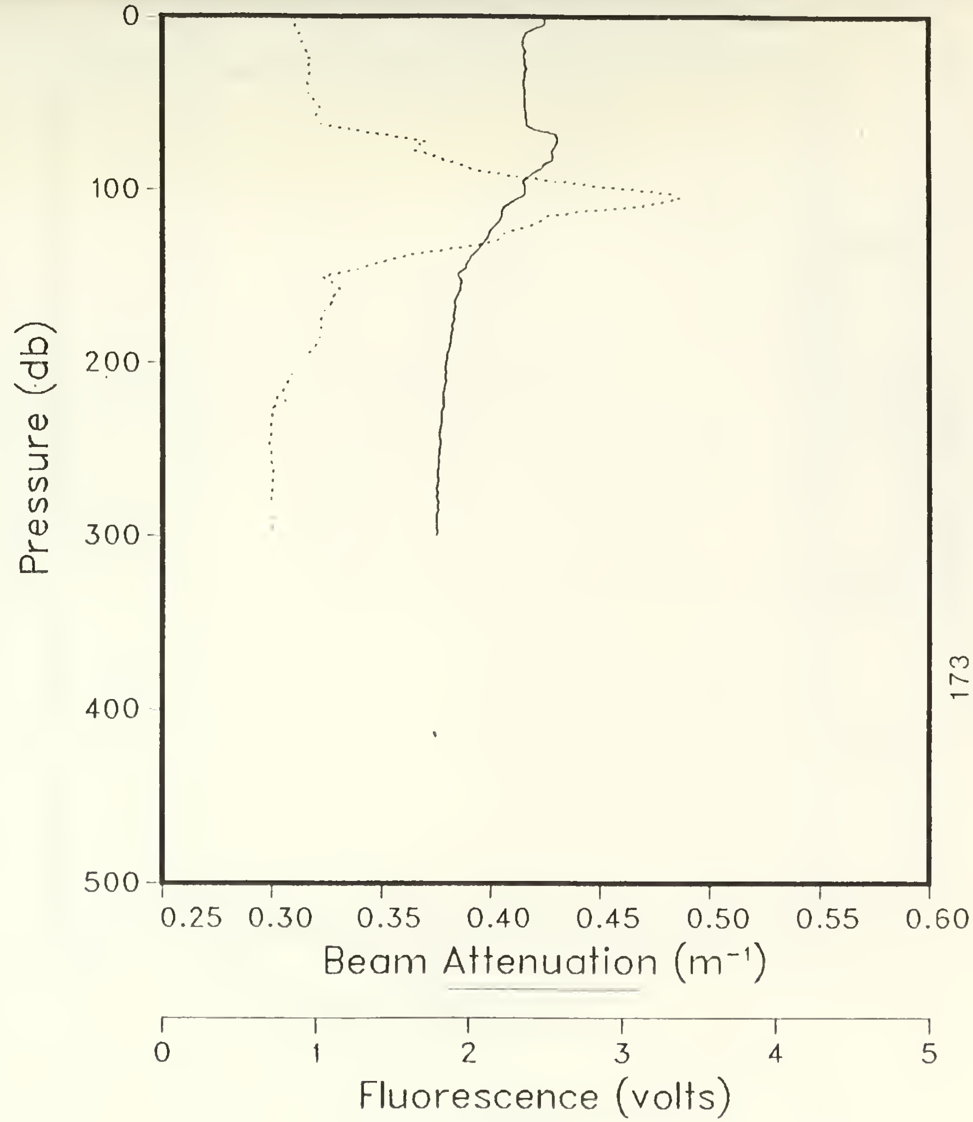


Latitude: 32.153°
Longitude: 141.830°

Date: 11/6/82
Time: 1138:50 GMT

R/V ACANIA CRUISE ODEX3 STATION 113

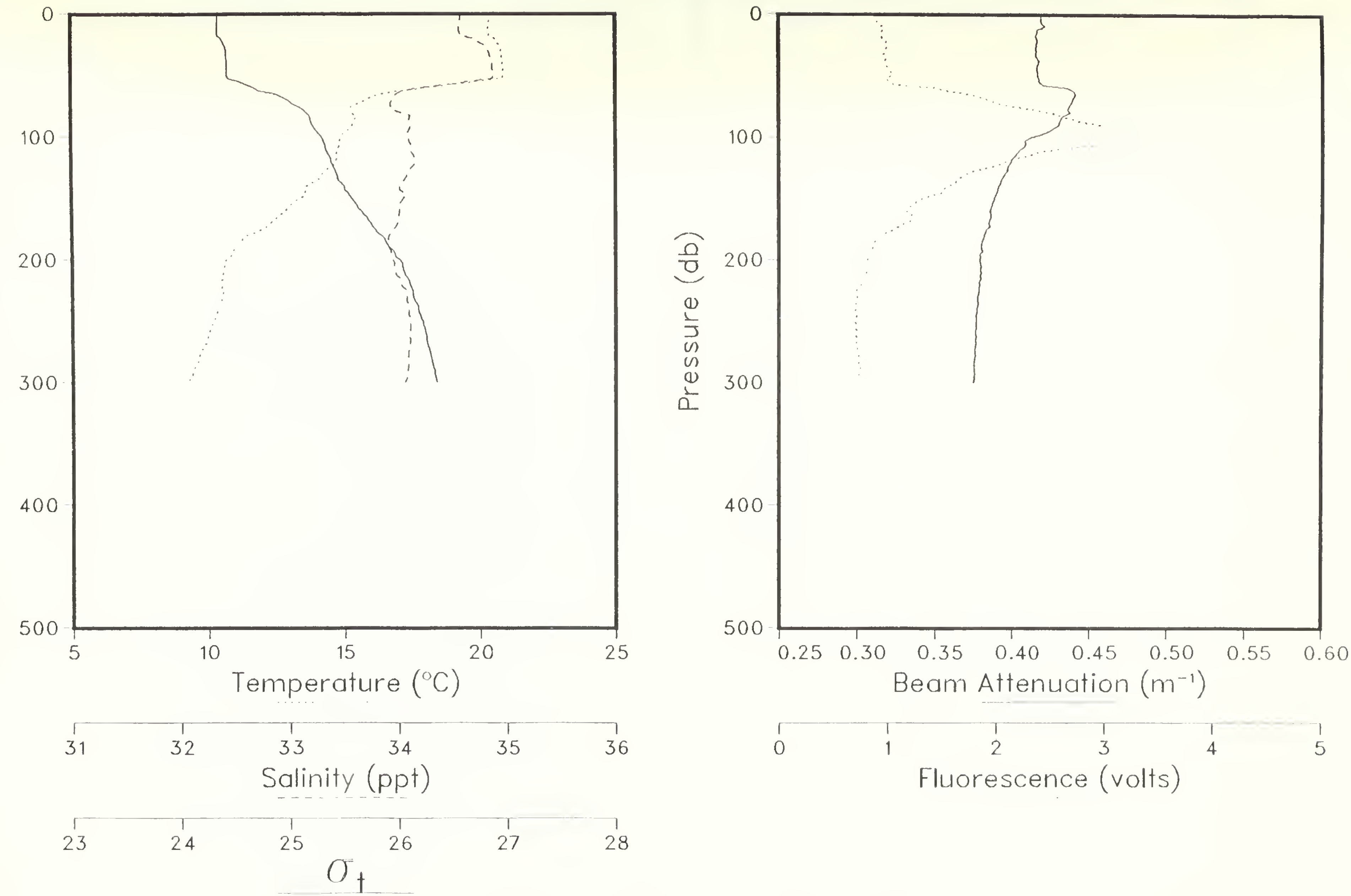




Latitude: 32.178°
Longitude: 141.978°

Date: 11/6/82
Time: 1310:27 GMT

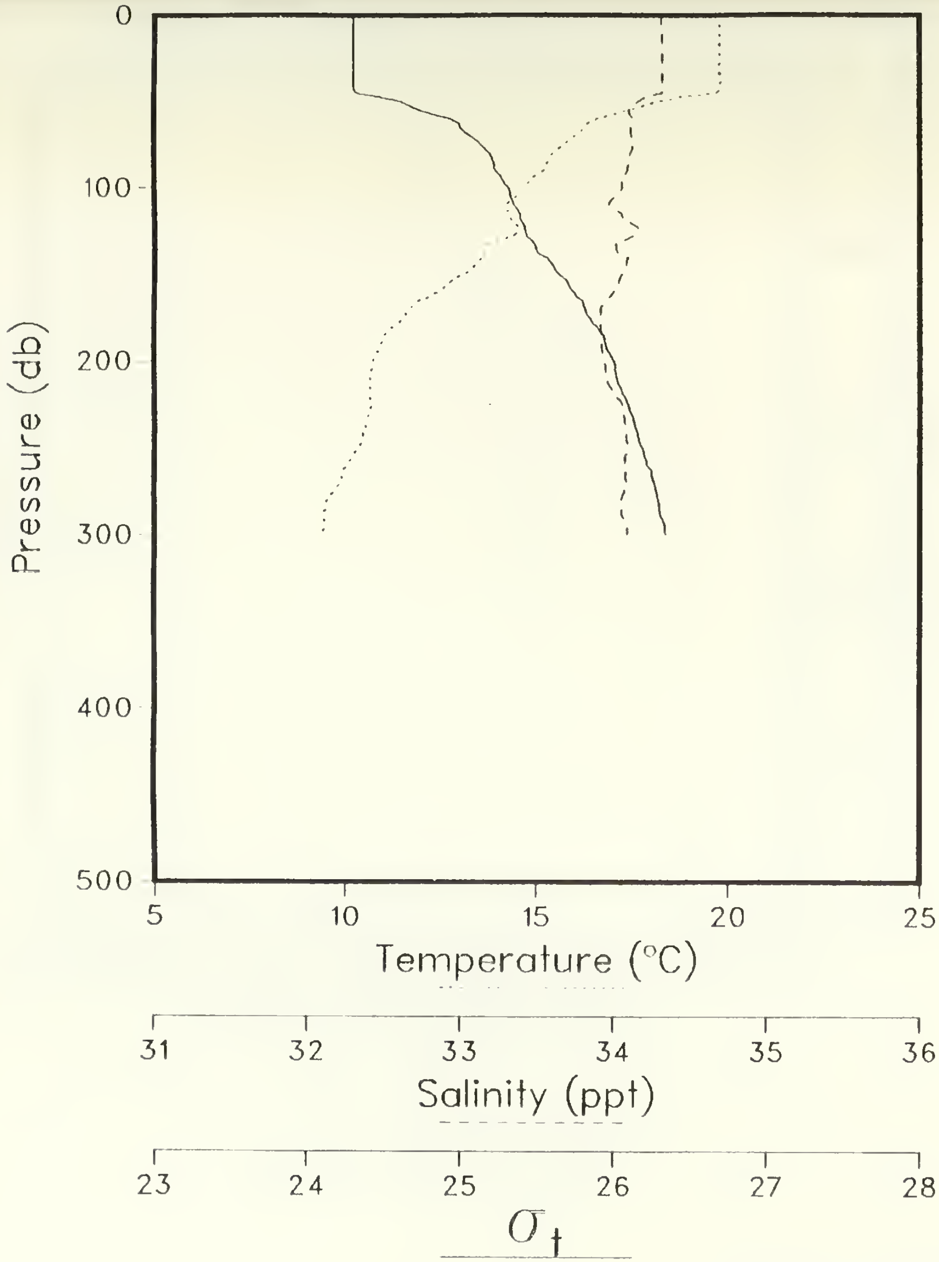
R/V ACANIA CRUISE ODEX3 STATION 114

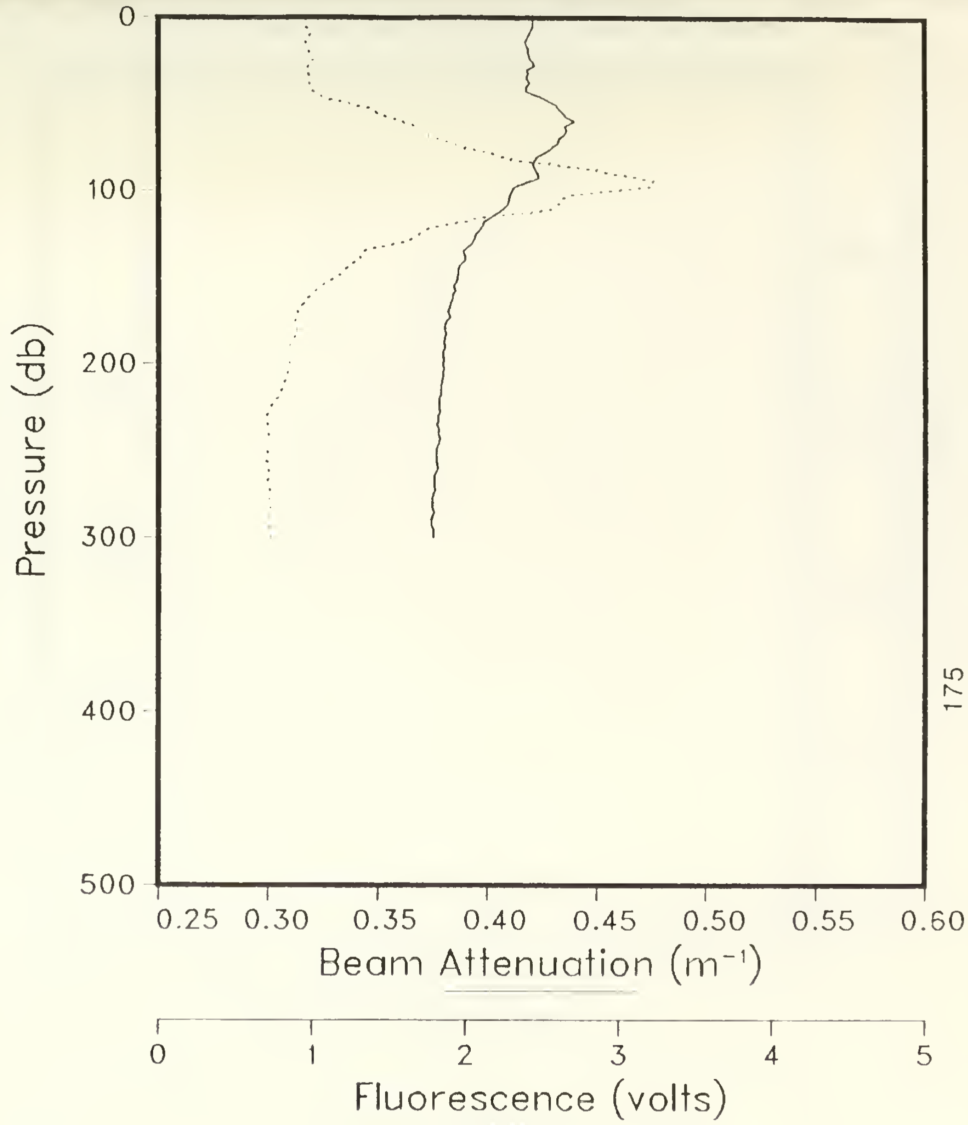


Latitude: 32.197°
Longitude: 142.102°

Date: 11/6/82
Time: 1451:15 GMT

R/V ACANIA CRUISE ODEX3 STATION 115

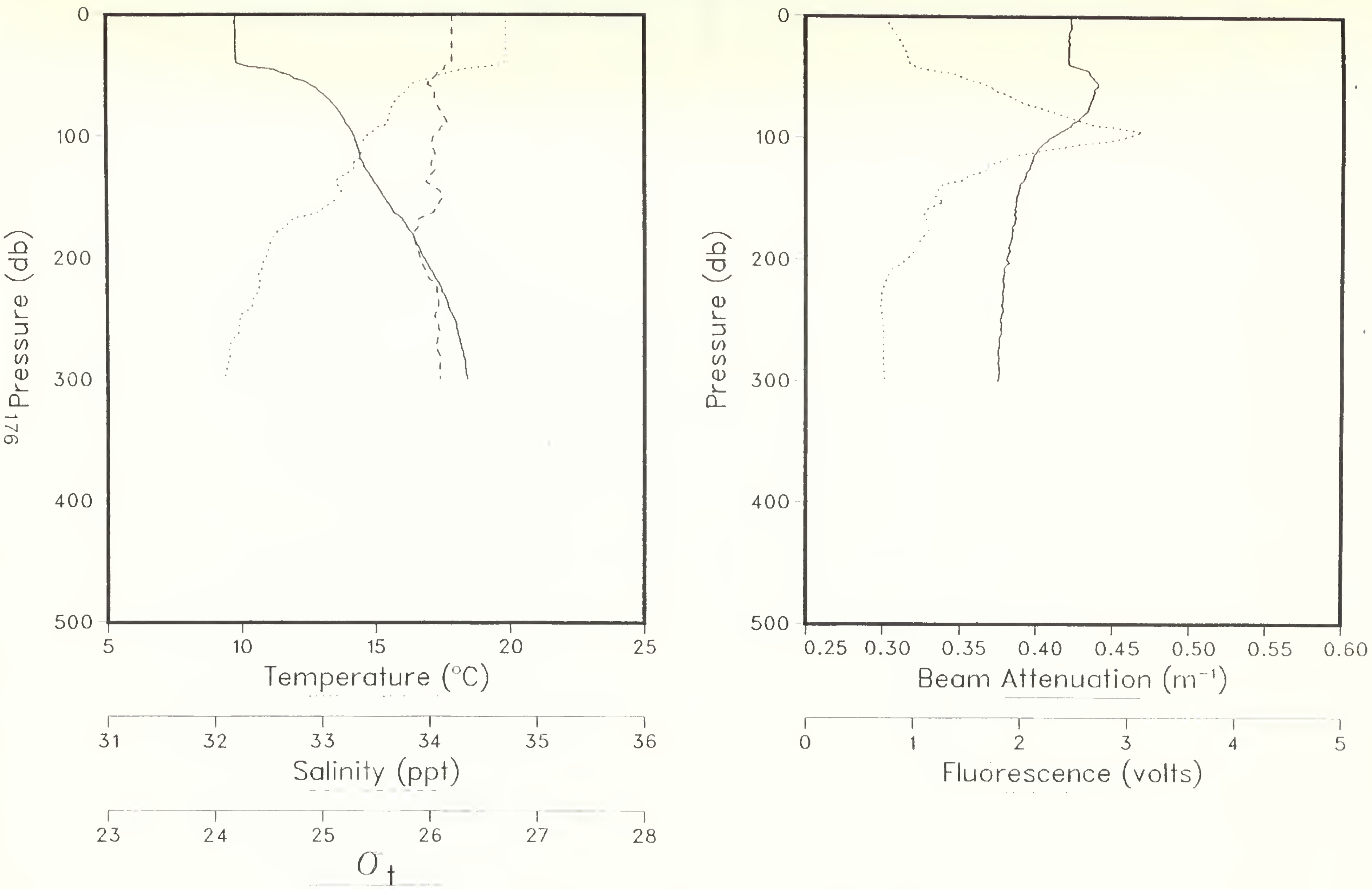




Latitude: 32.293°
Longitude: 142.076°

Date: 11/6/82
Time: 1645:00 GMT

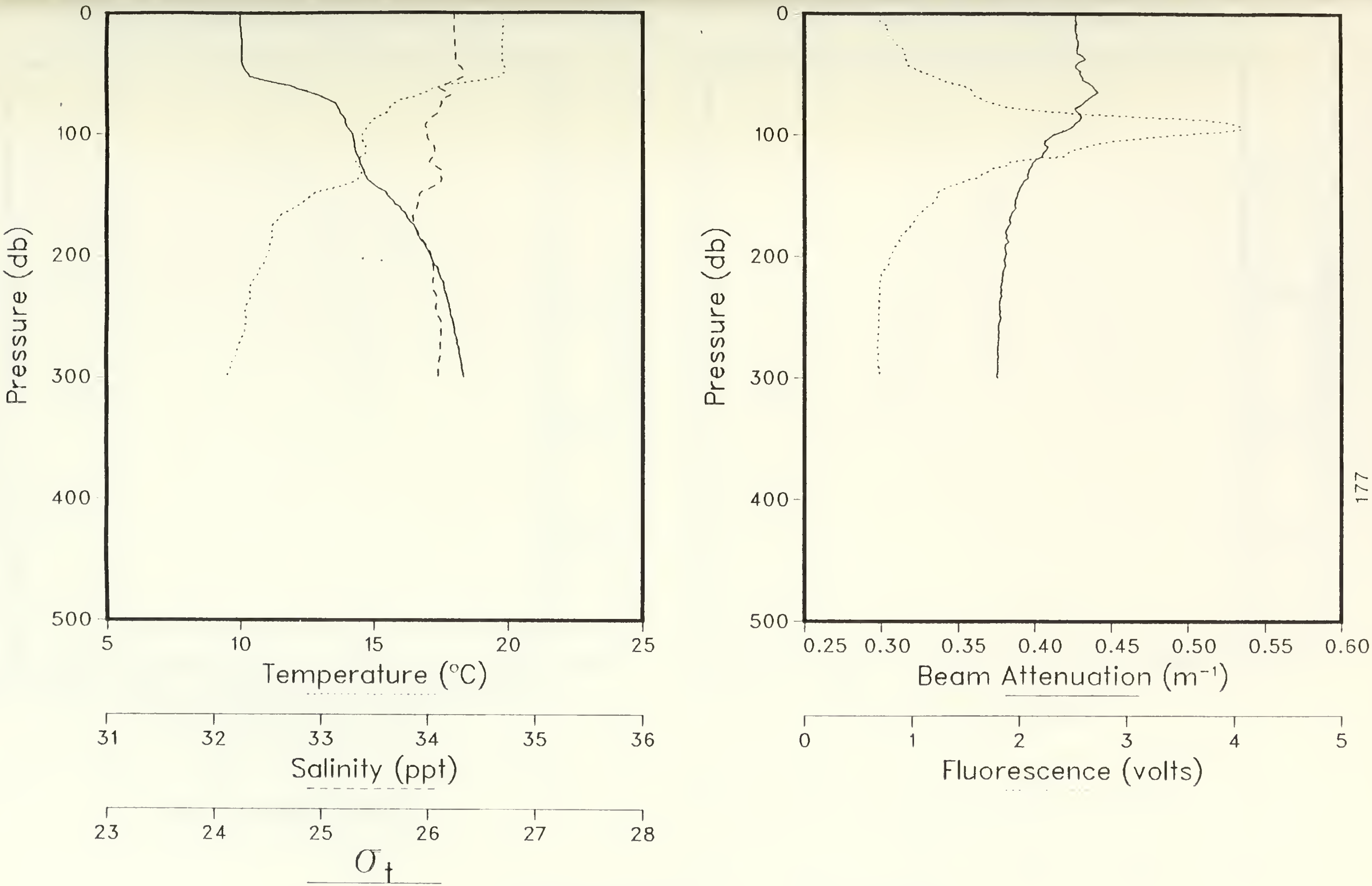
R/V ACANIA CRUISE ODEX3 STATION 116



Latitude: 32.398°
Longitude: 142.081°

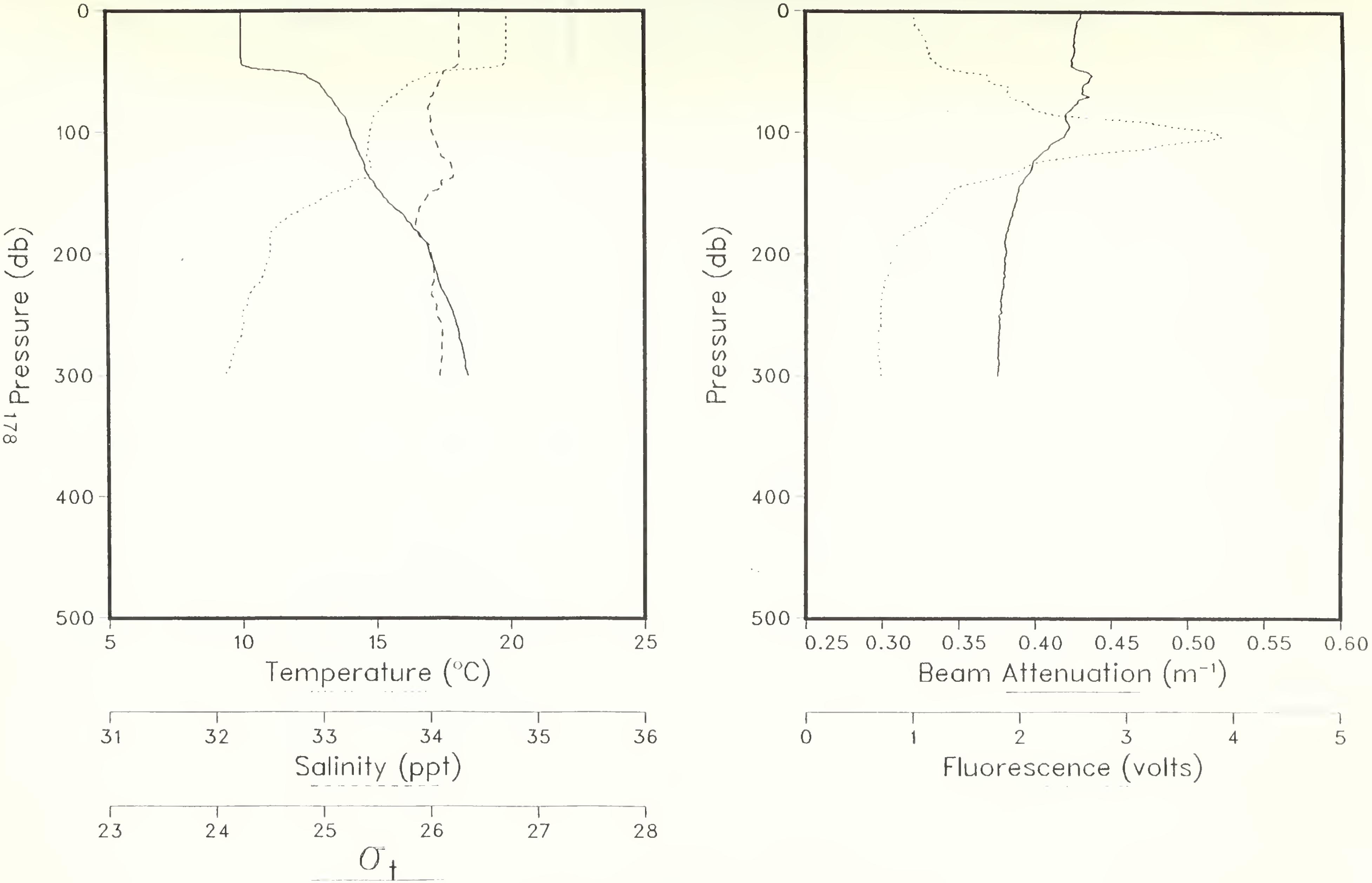
Date: 11/6/82
Time: 1900:24 GMT

R/V ACANIA CRUISE ODEX3 STATION 117



Latitude: 32.522° Date: 11/6/82
Longitude: 142.048° Time: 2157:28 GMT

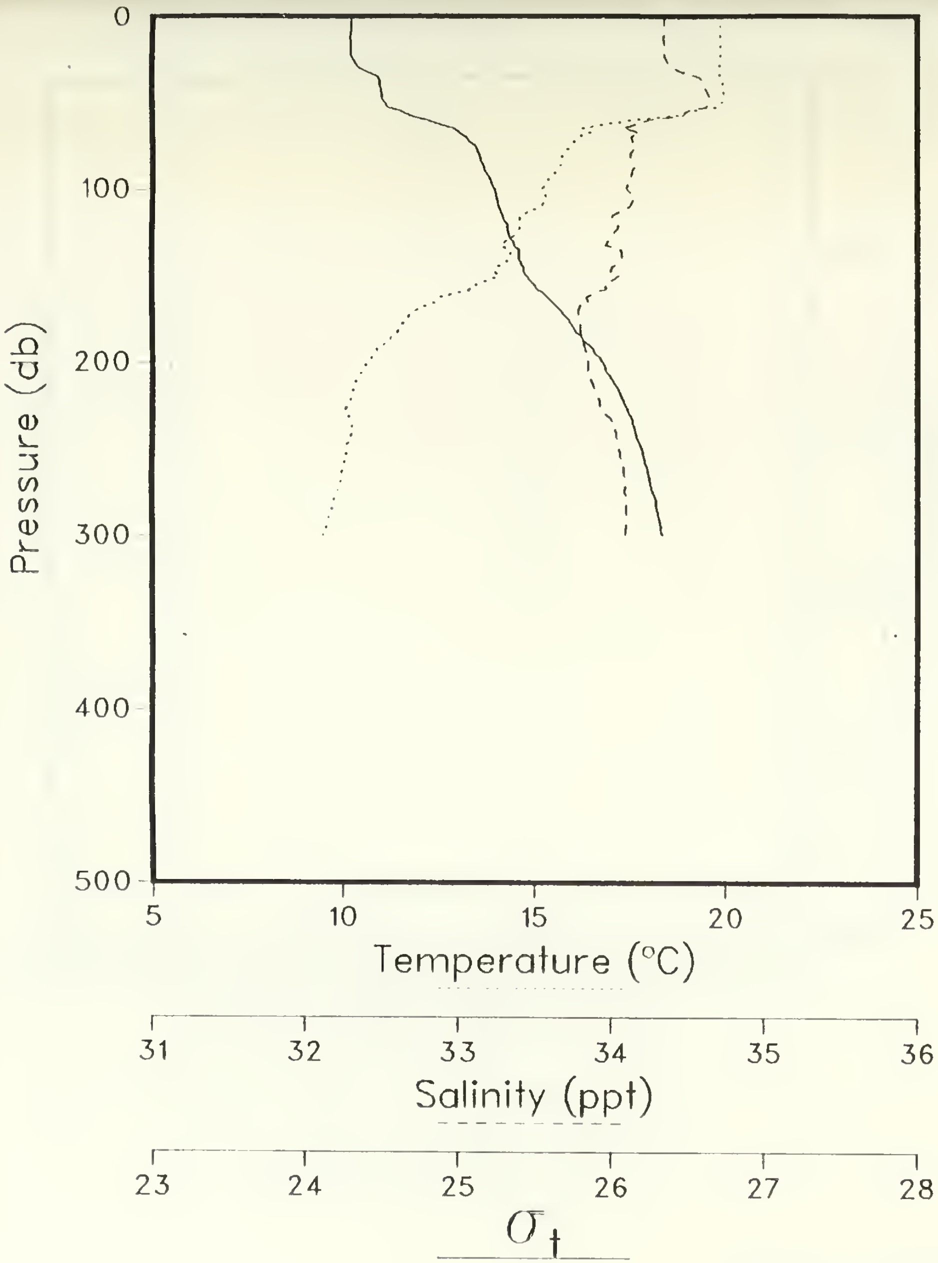
R/V ACANIA CRUISE ODEX3 STATION 118

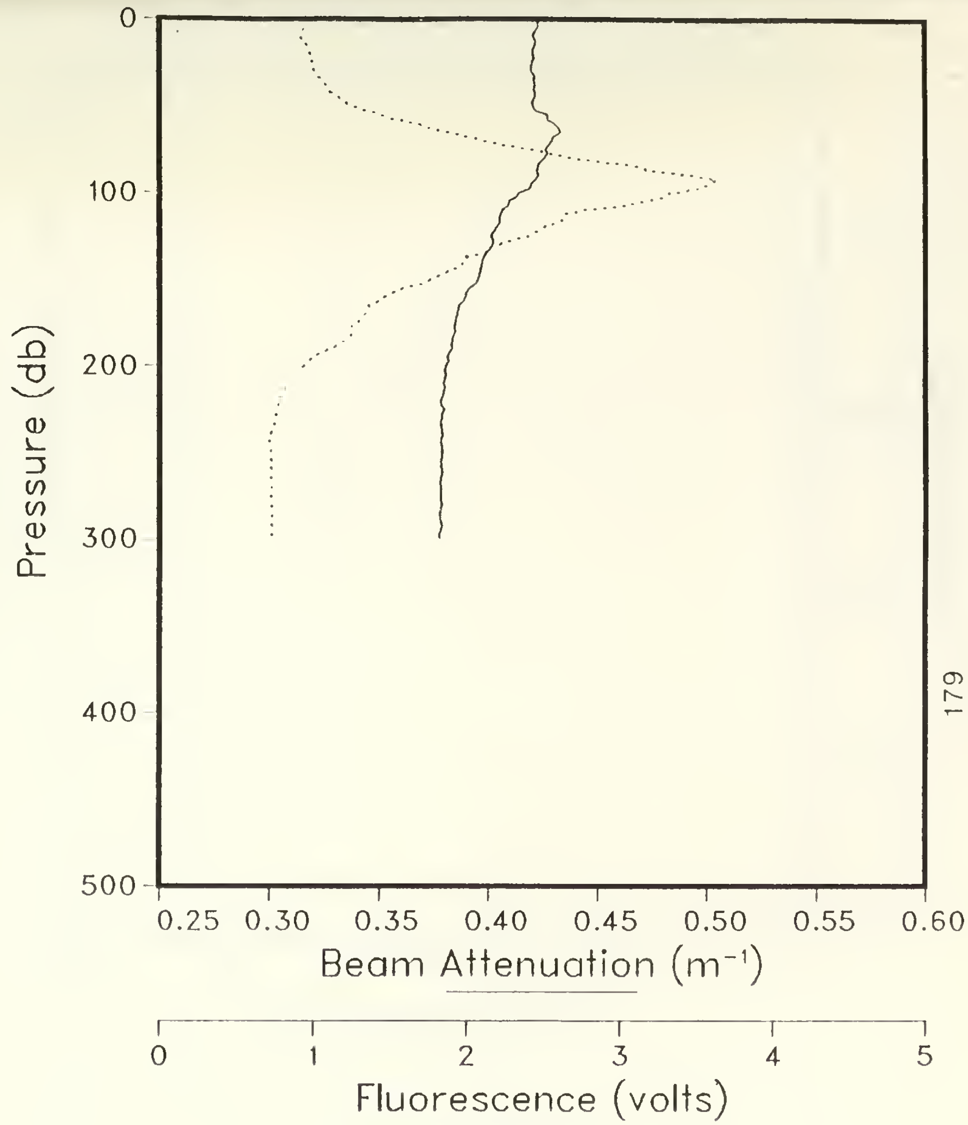


Latitude: 32.641°
Longitude: 142.112°

Date: 11/7/82
Time: 321:19 GMT

R/V ACANIA CRUISE ODEX3 STATION 119

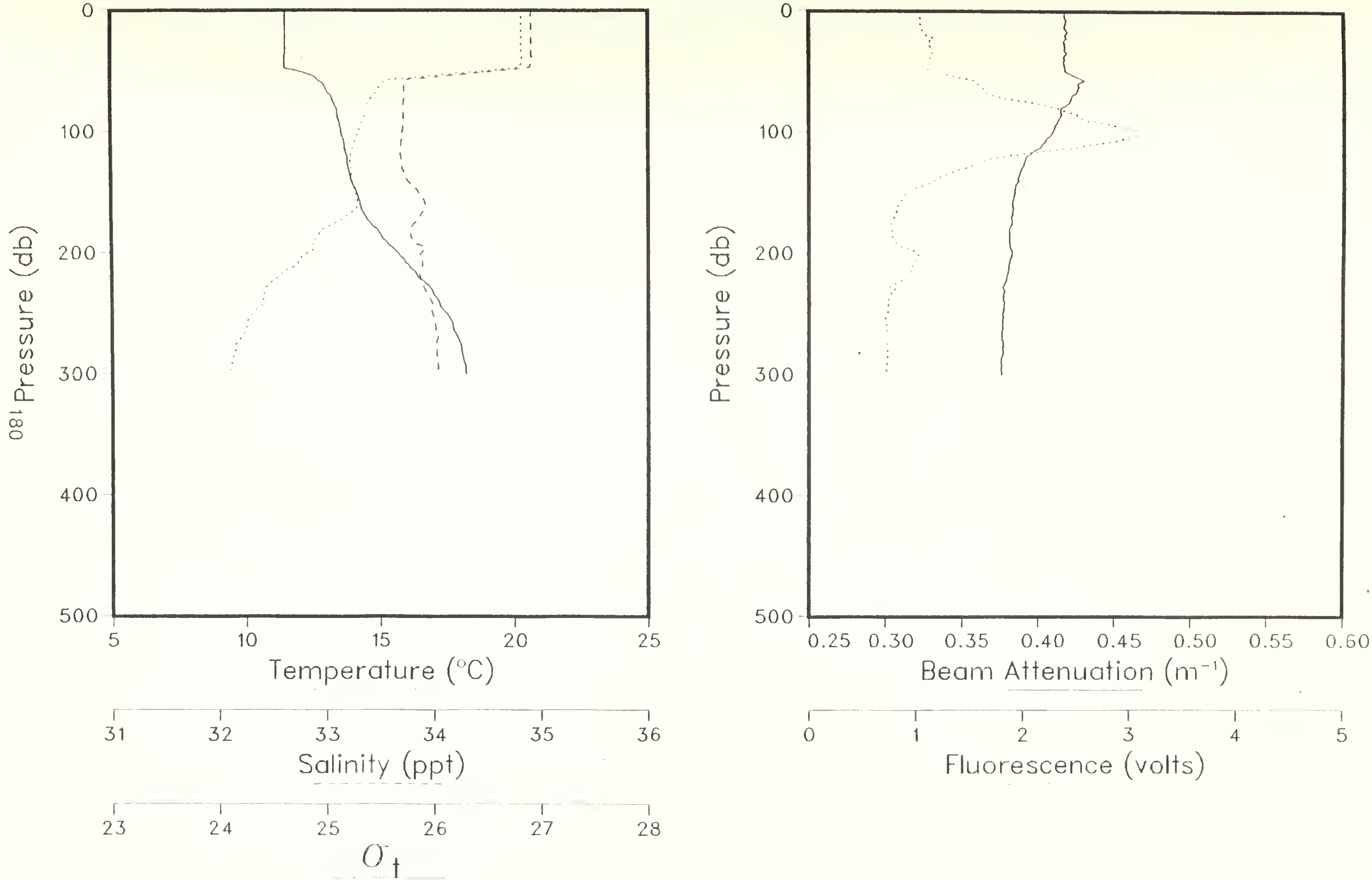




Latitude: 32.883°
Longitude: 142.083°

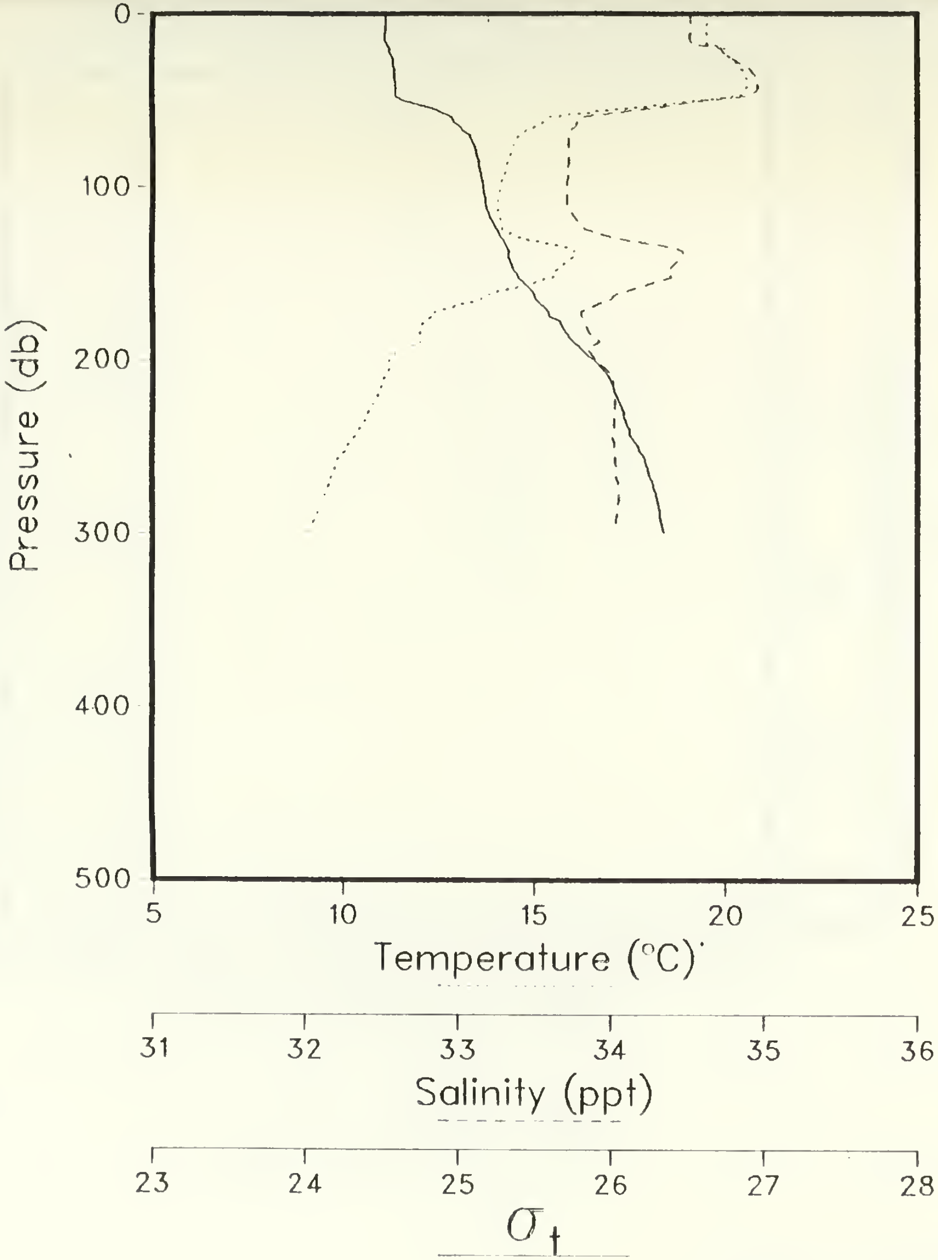
Date: 11/7/82
Time: 741:08 GMT

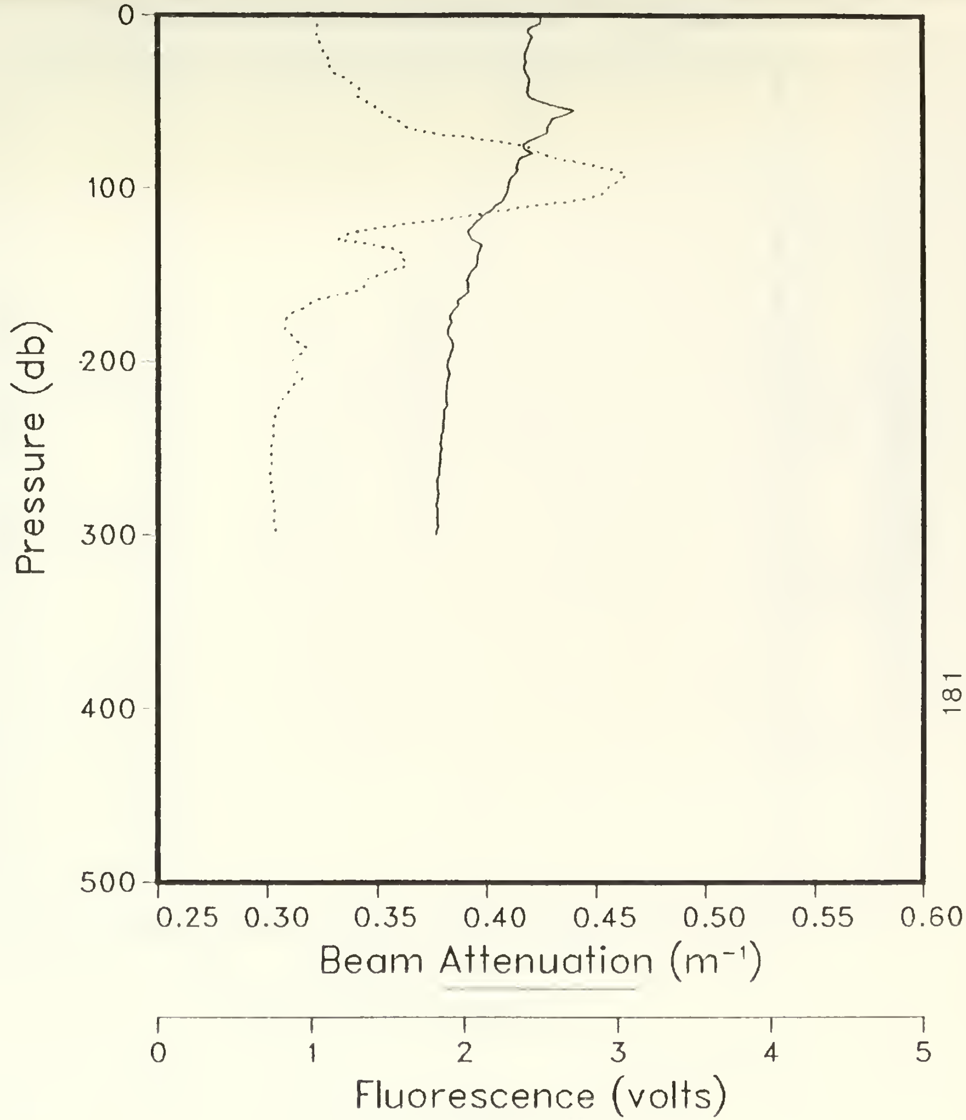
R/V ACANIA CRUISE ODEX3 STATION 120



Latitude: 33.117° Date: 11/7/82
Longitude: 142.083° Time: 1142:23 GMT

R/V ACANIA CRUISE ODEX3 STATION 121

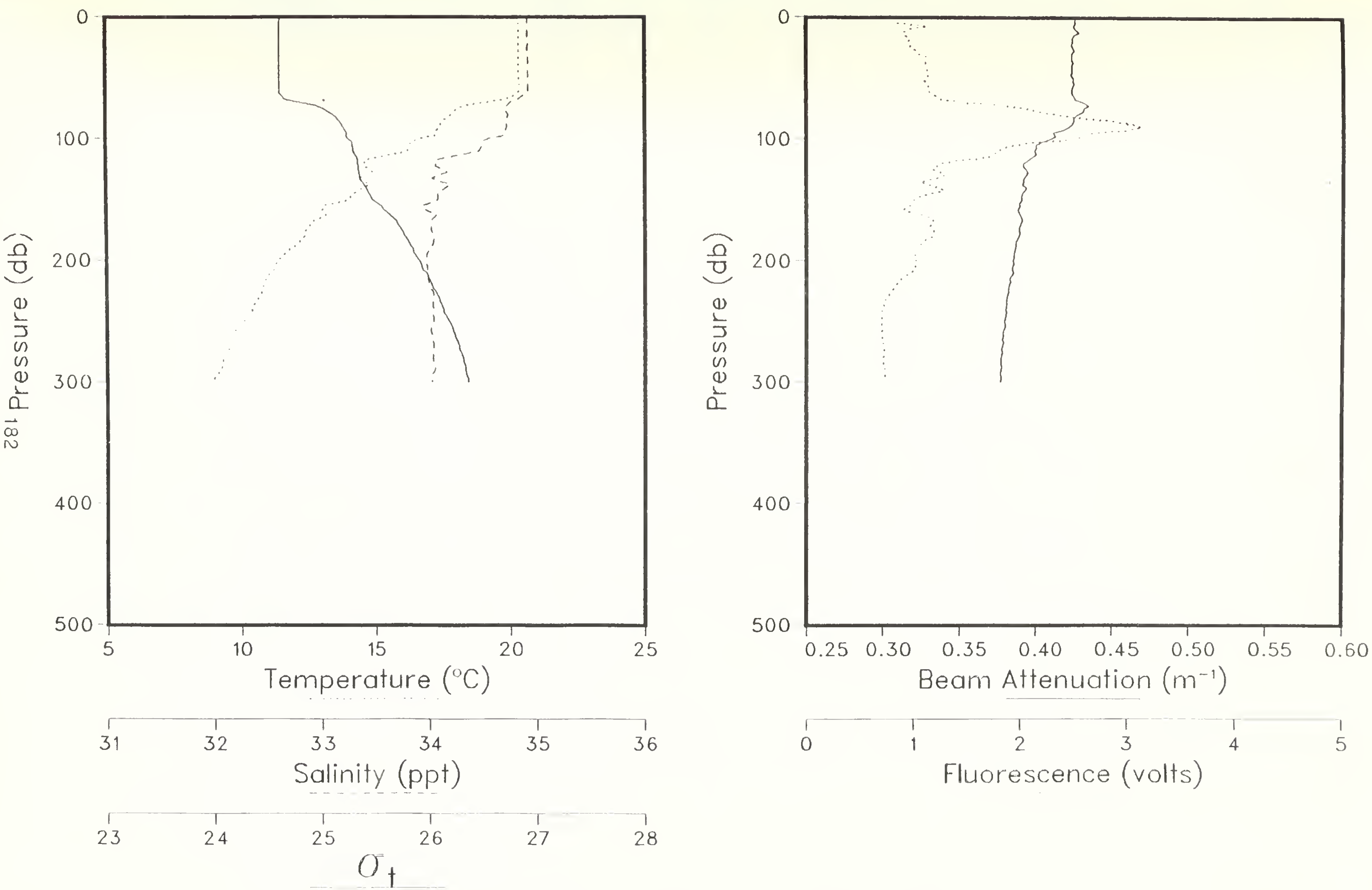




Latitude: 33.339° Longitude: 142.100°

Date: 11/7/82 Time: 1616:23 GMT

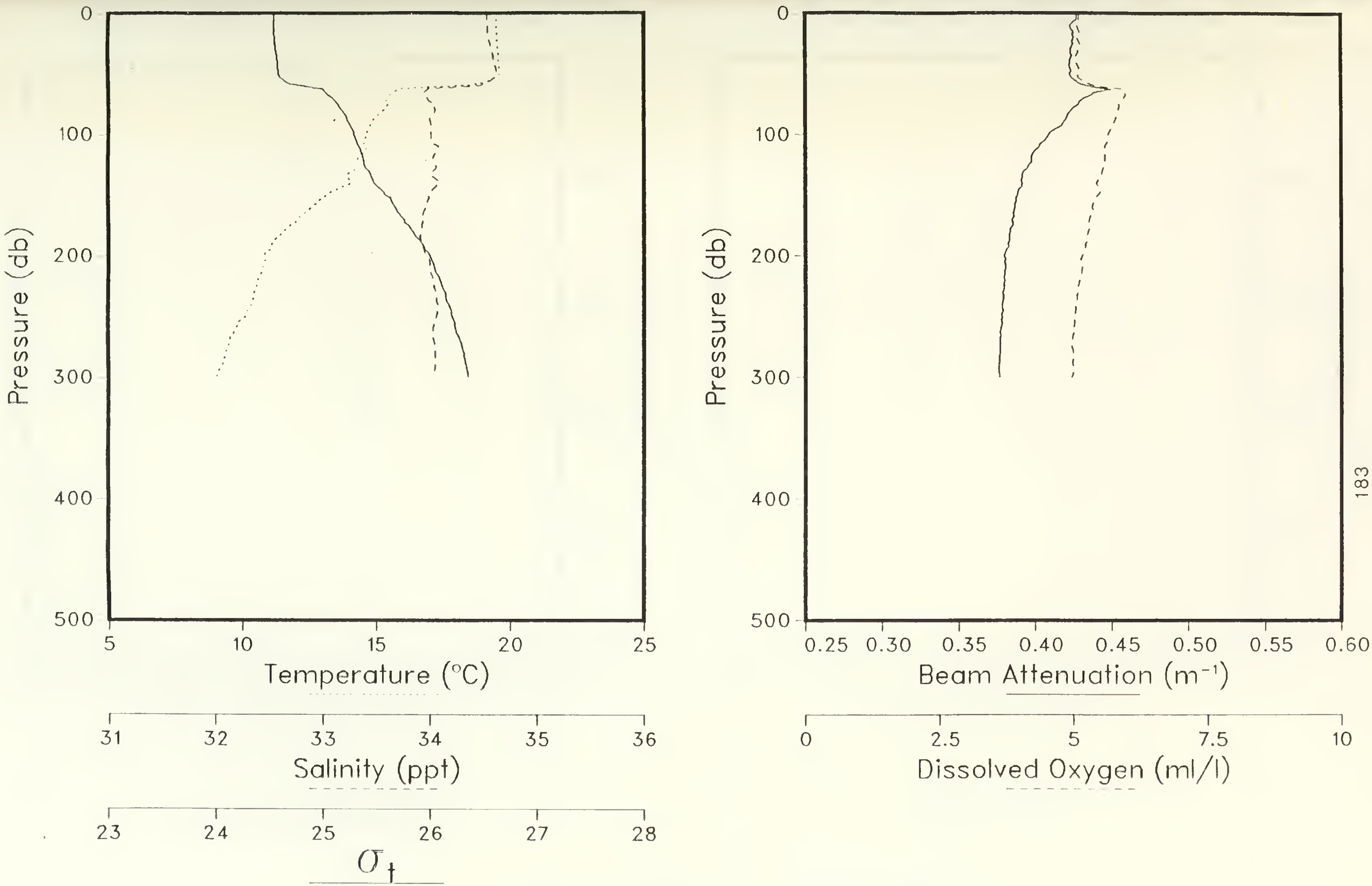
R/V ACANIA CRUISE ODEX3 STATION 122



Latitude: 33.462°
Longitude: 142.088°

Date: 11/7/82
Time: 2036:58 GMT

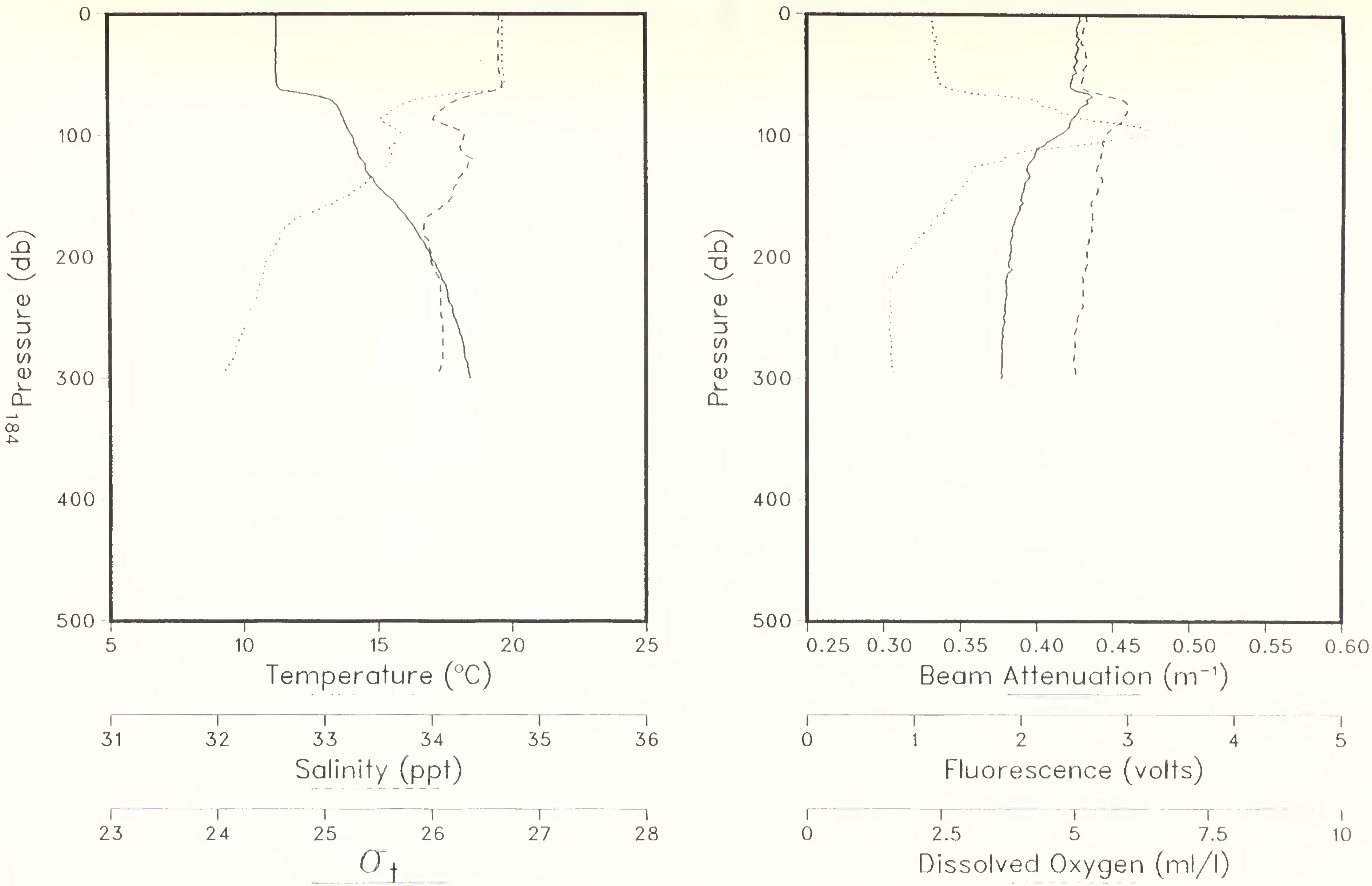
R/V ACANIA CRUISE ODEX3 STATION 123



Latitude: 33.590°
Longitude: 142.100°

Date: 11/7/82
Time: 3:47 GMT

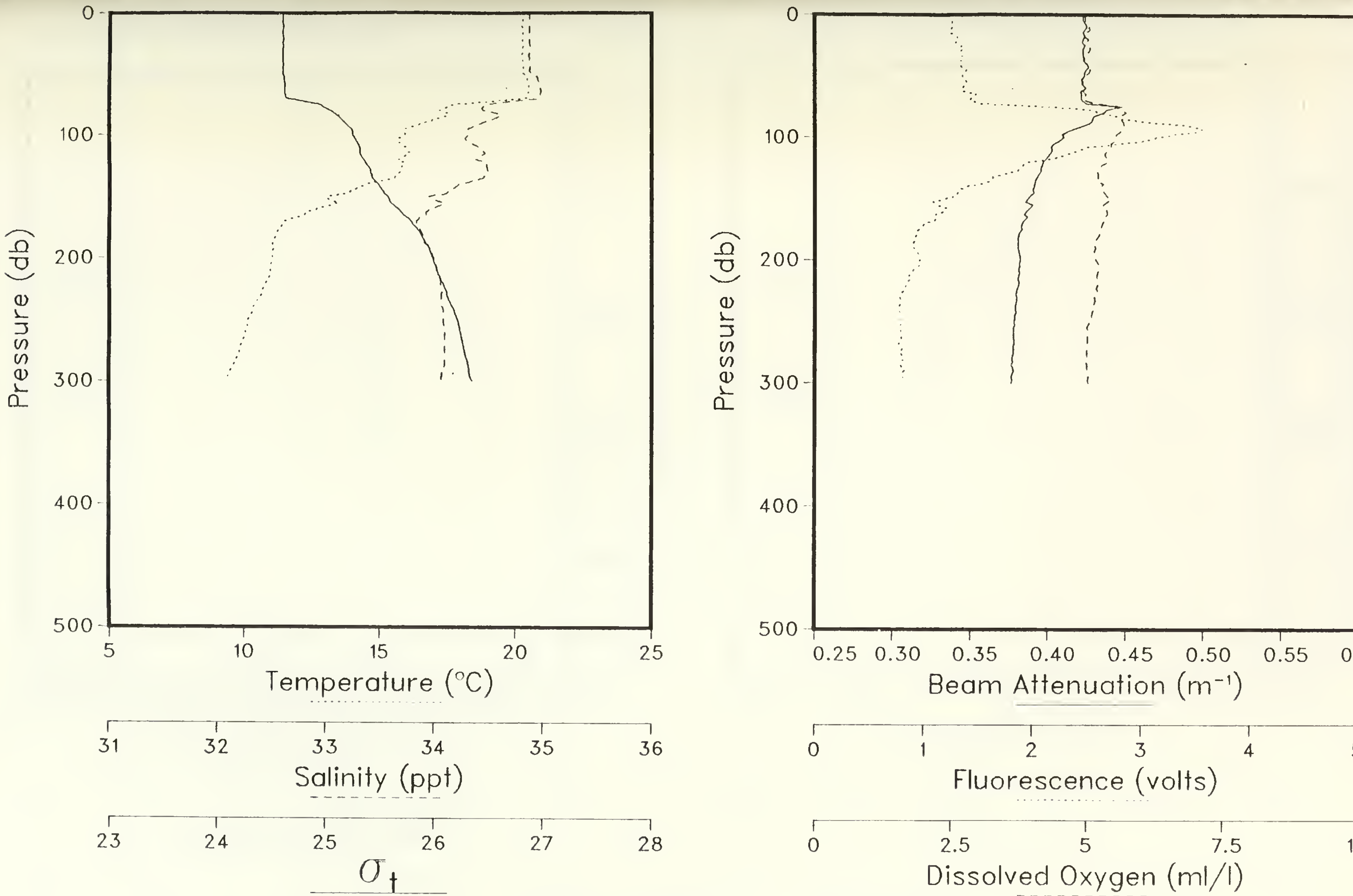
R/V ACANIA CRUISE ODEX3 STATION 124



Latitude: 33.590°
Longitude: 142.249°

Date: 11/8/82
Time: 158:19 GMT

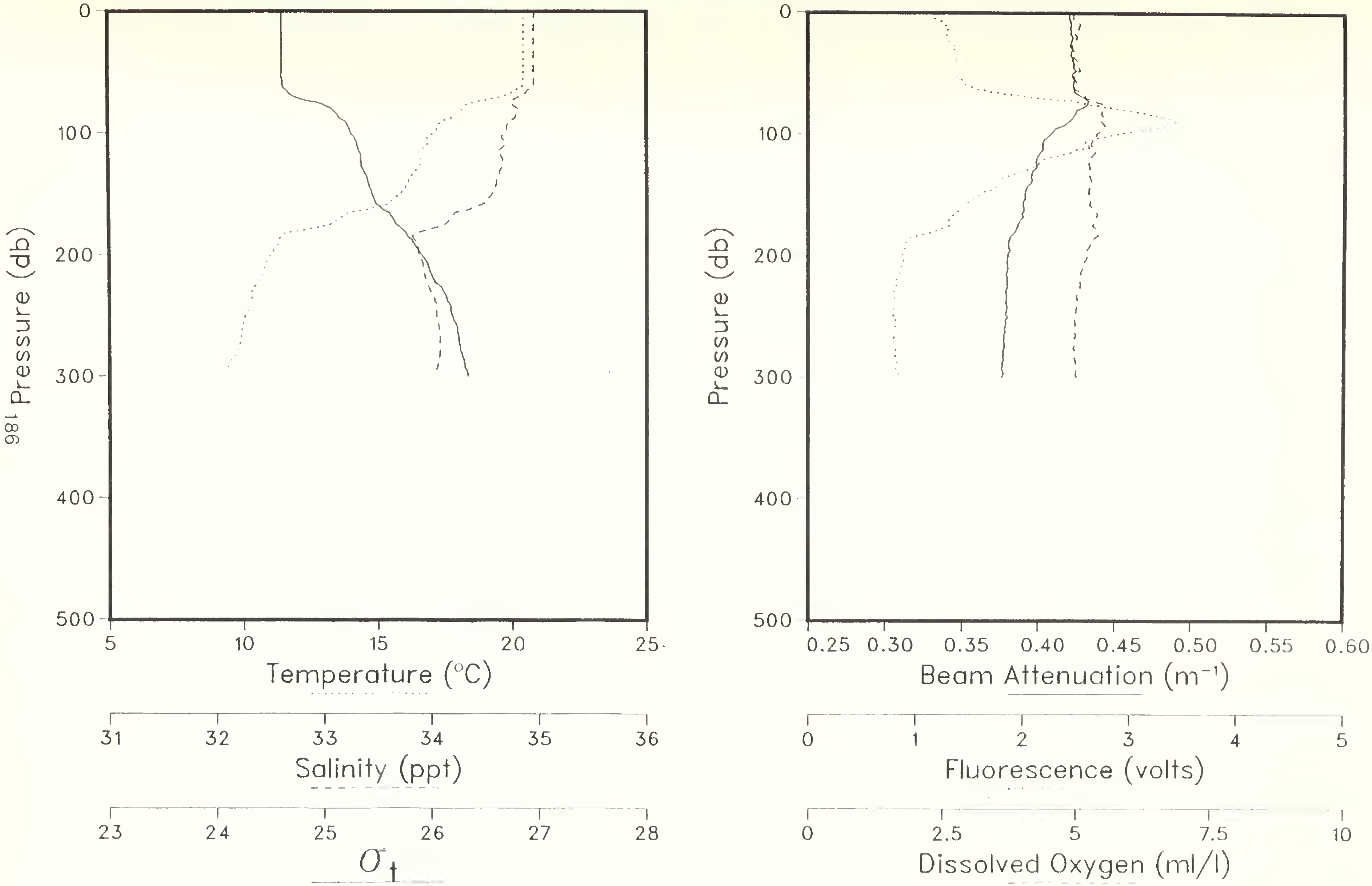
R/V ACANIA CRUISE ODEX3 STATION 125



Latitude: 33.593°
Longitude: 142.385°

Date: 11/8/82
Time: 335:06 GMT

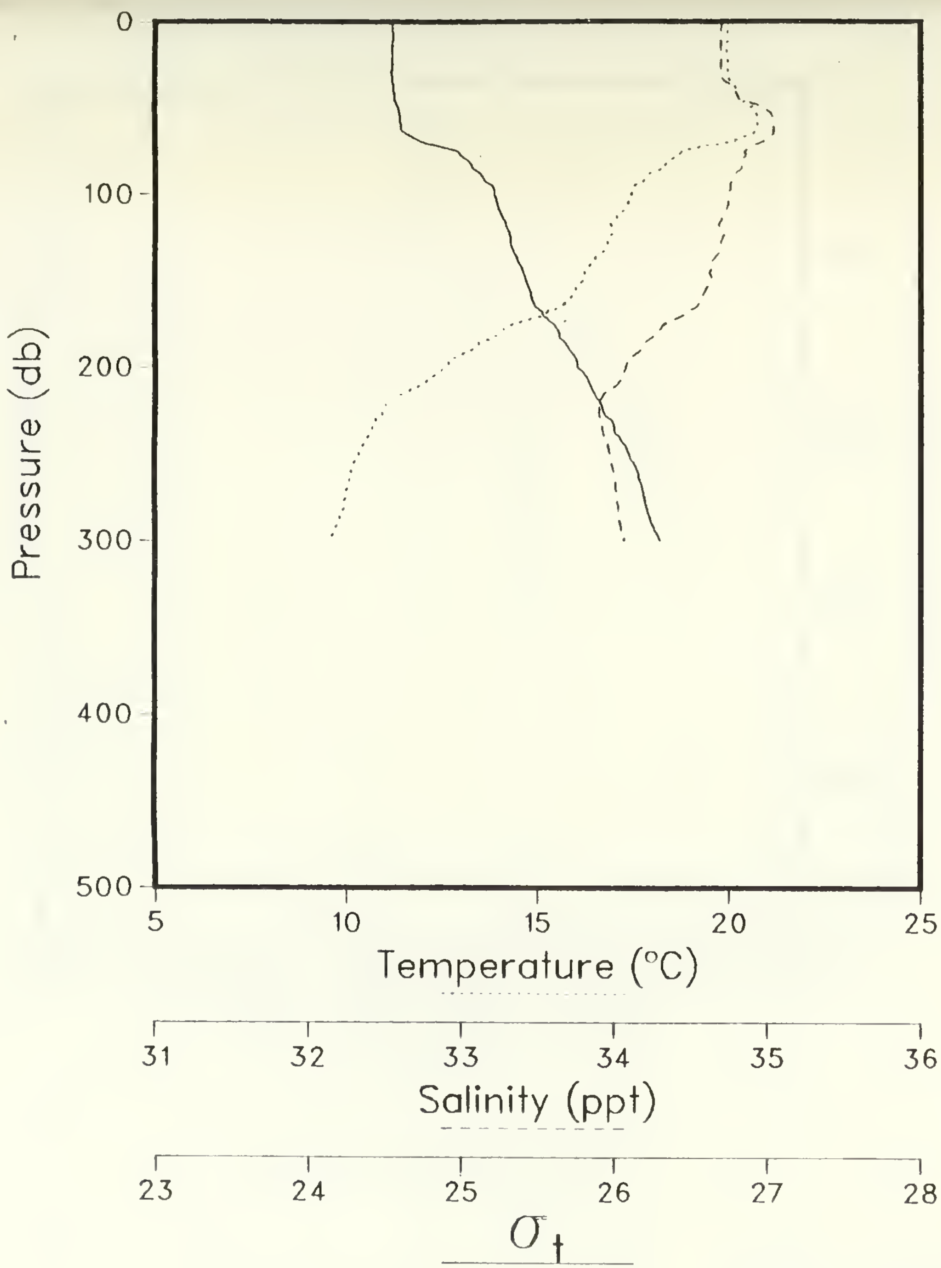
R/V ACANIA CRUISE ODEX3 STATION 126

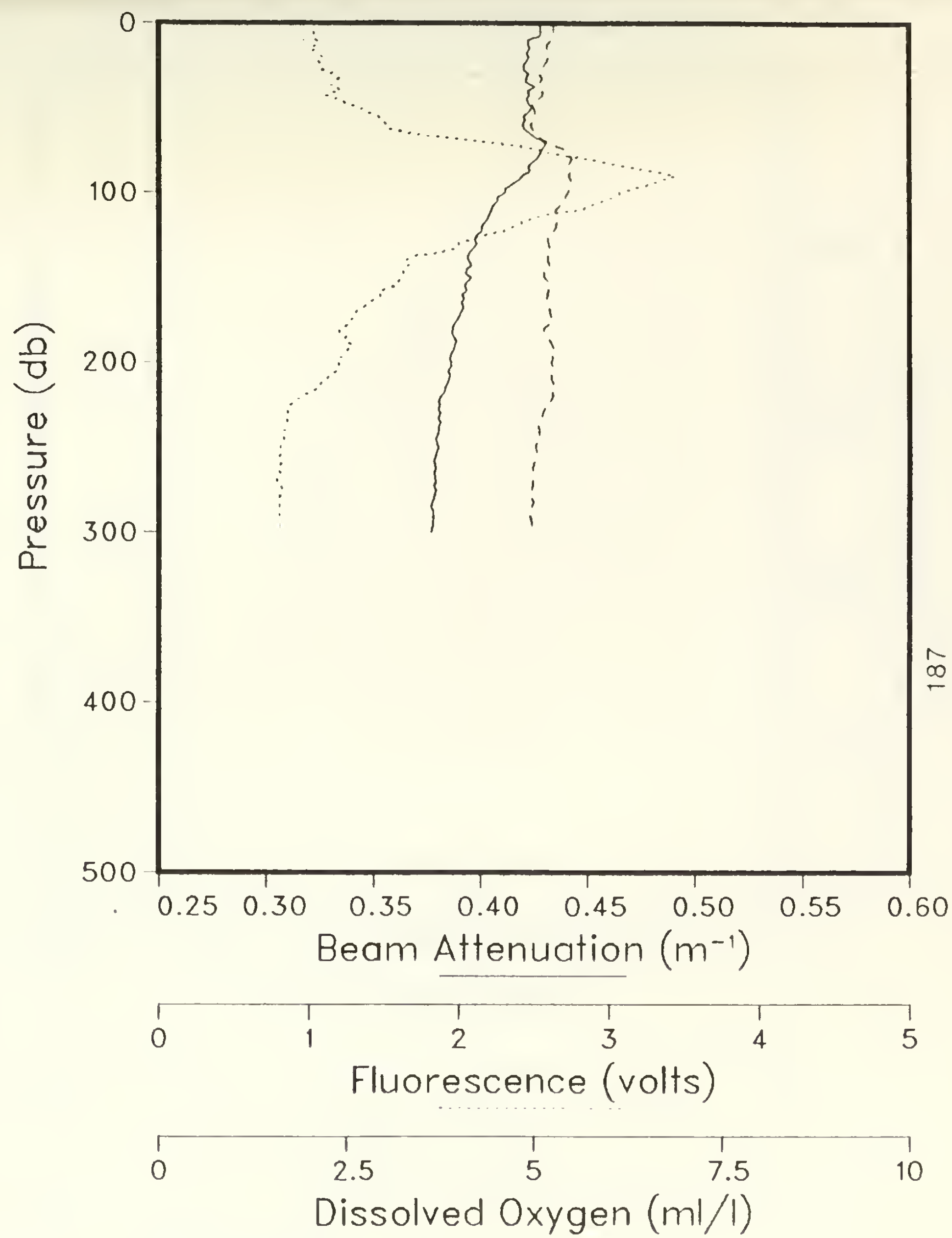


Latitude: 33.475°
Longitude: 142.382°

Date: 11/8/82
Time: 518:20 GMT

R/V ACANIA CRUISE ODEX3 STATION 127

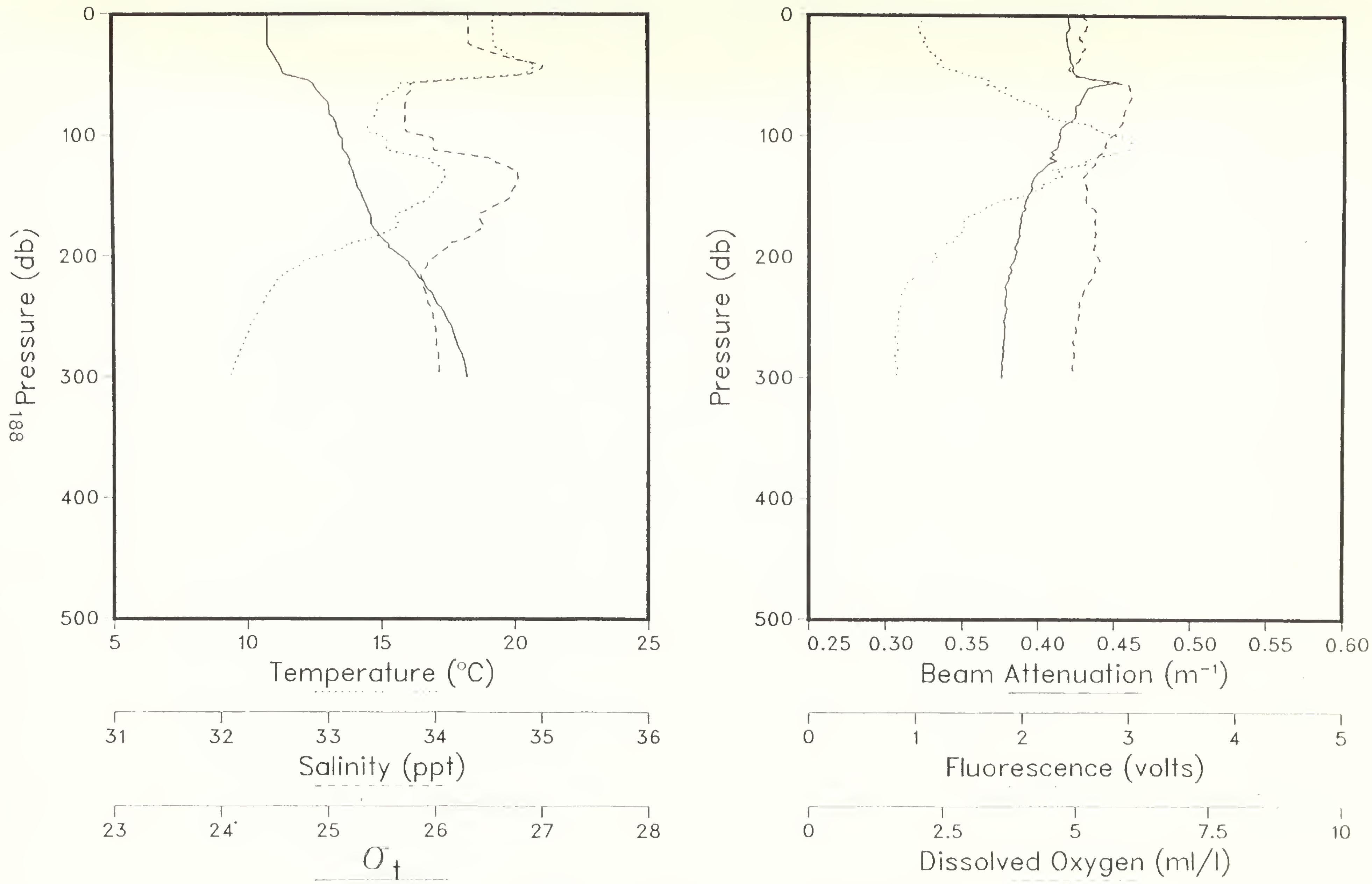




Latitude: 33.341°
Longitude: 142.345°

Date: 11/8/82
Time: 718:16 GMT

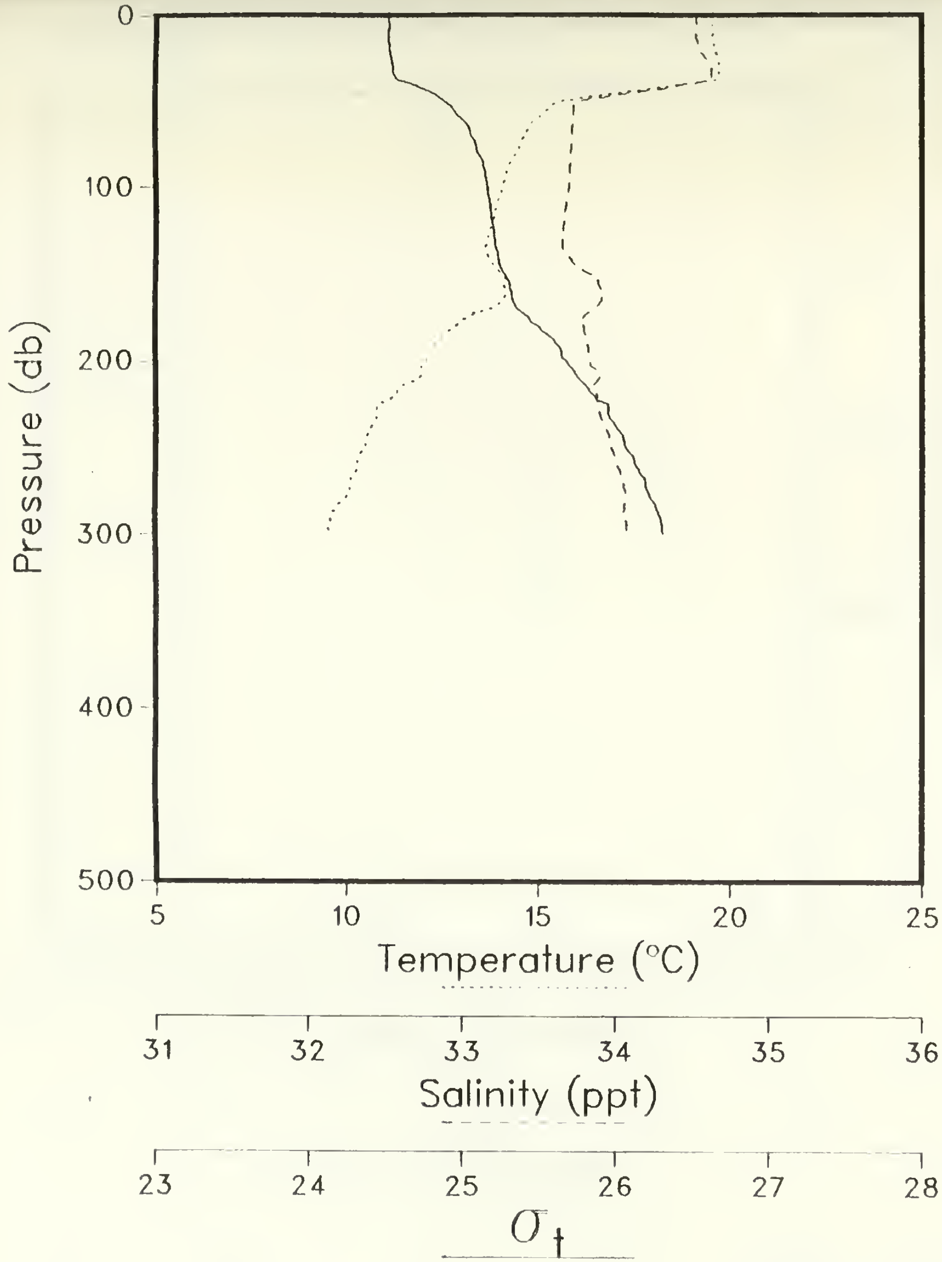
R/V ACANIA CRUISE ODEX3 STATION 128

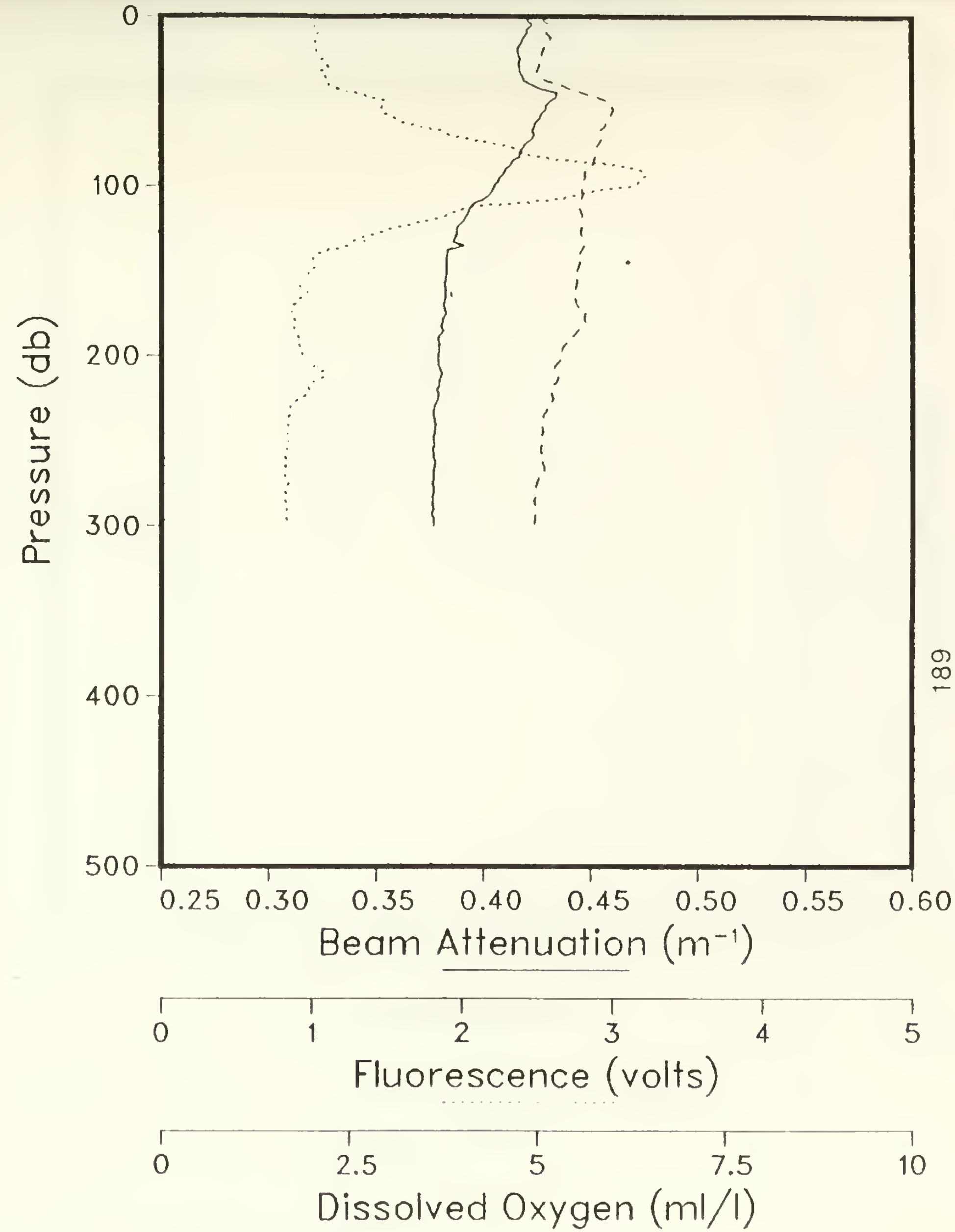


Latitude: 33.217°
Longitude: 142.357°

Date: 11/8/82
Time: 856:48 GMT

R/V ACANIA CRUISE ODEX3 STATION 129

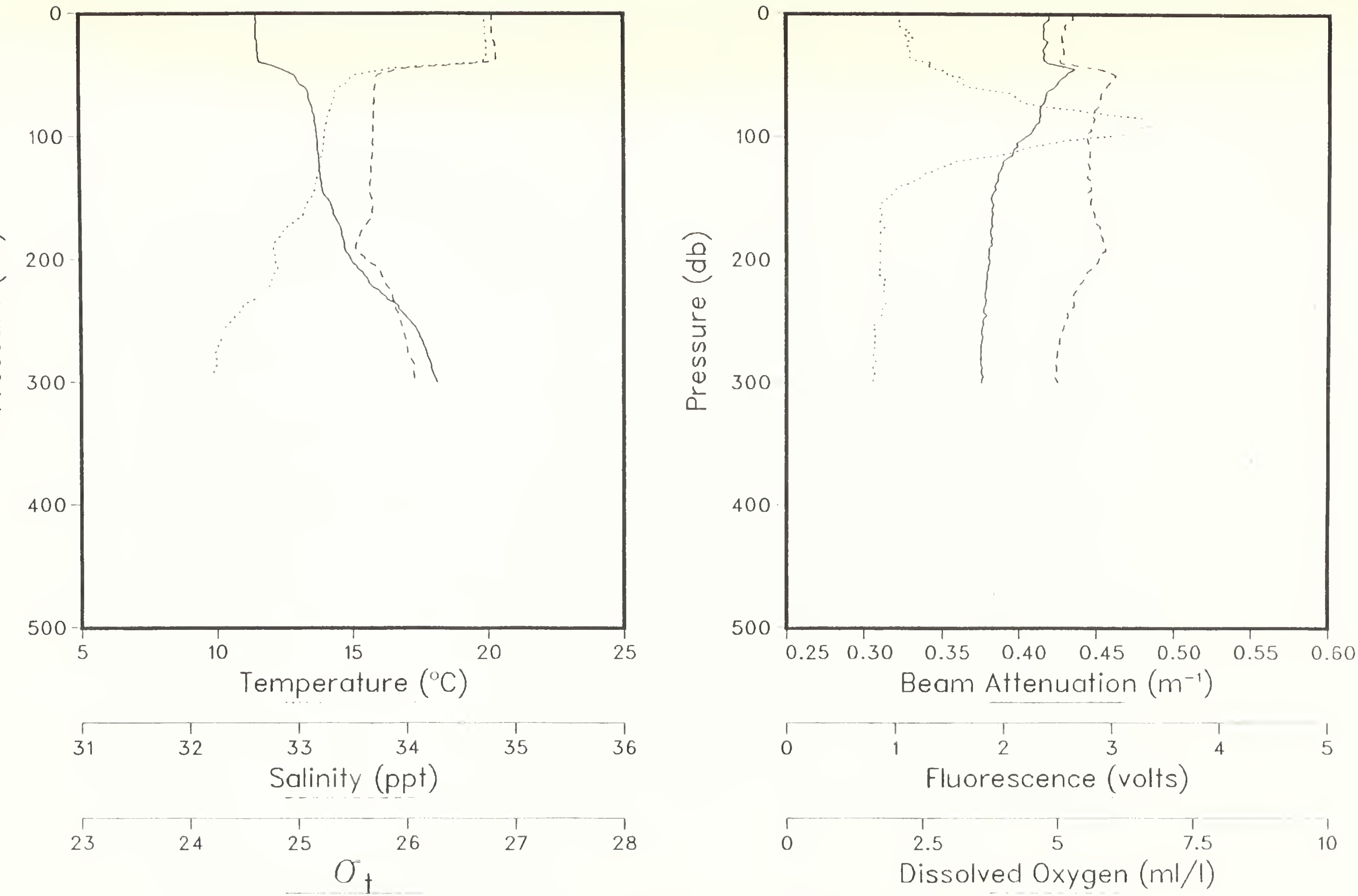




Latitude: 33.117°
Longitude: 142.367°

Date: 11/8/82
Time: 1042:41 GMT

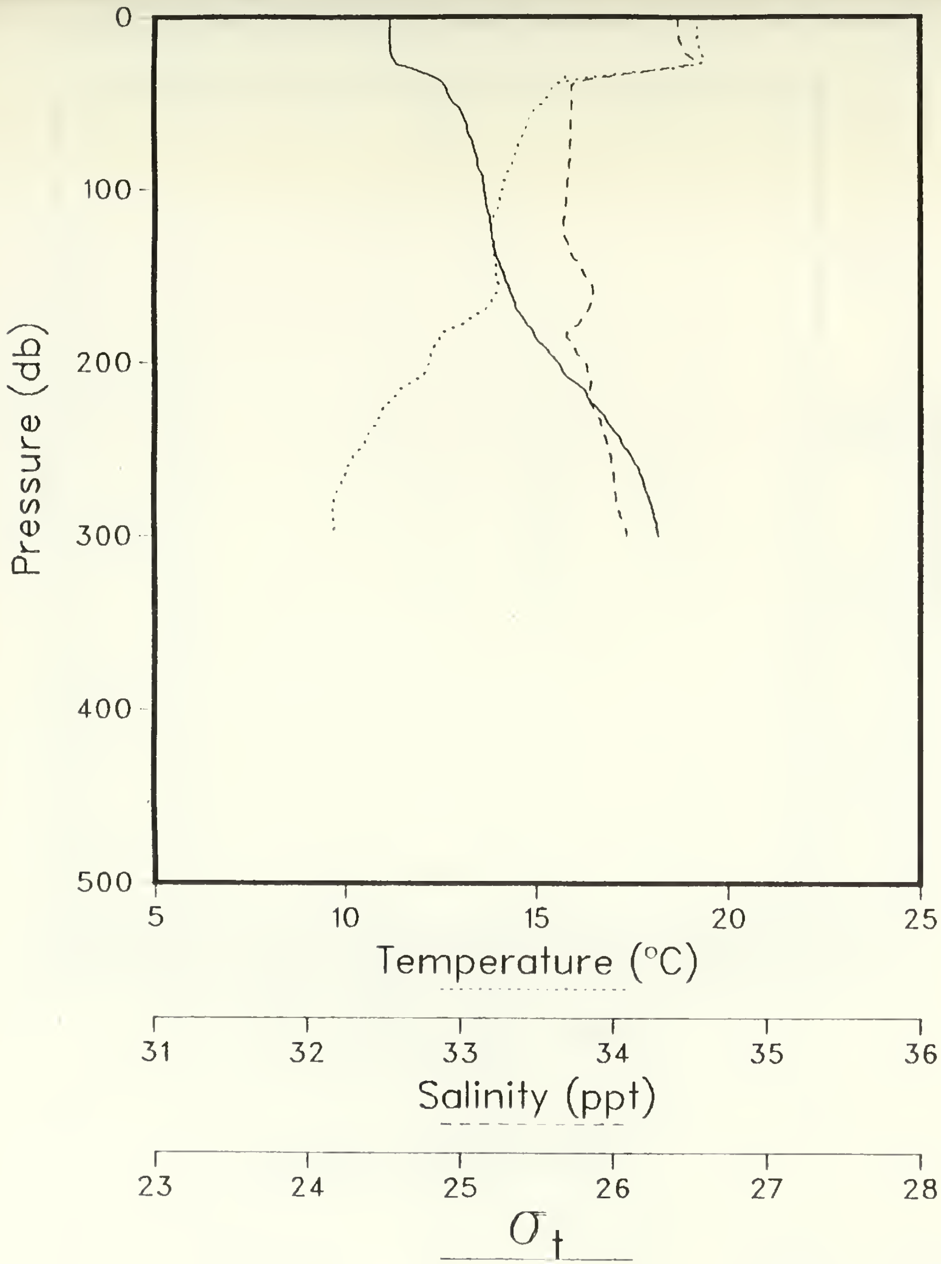
R/V ACANIA CRUISE ODEX3 STATION 130

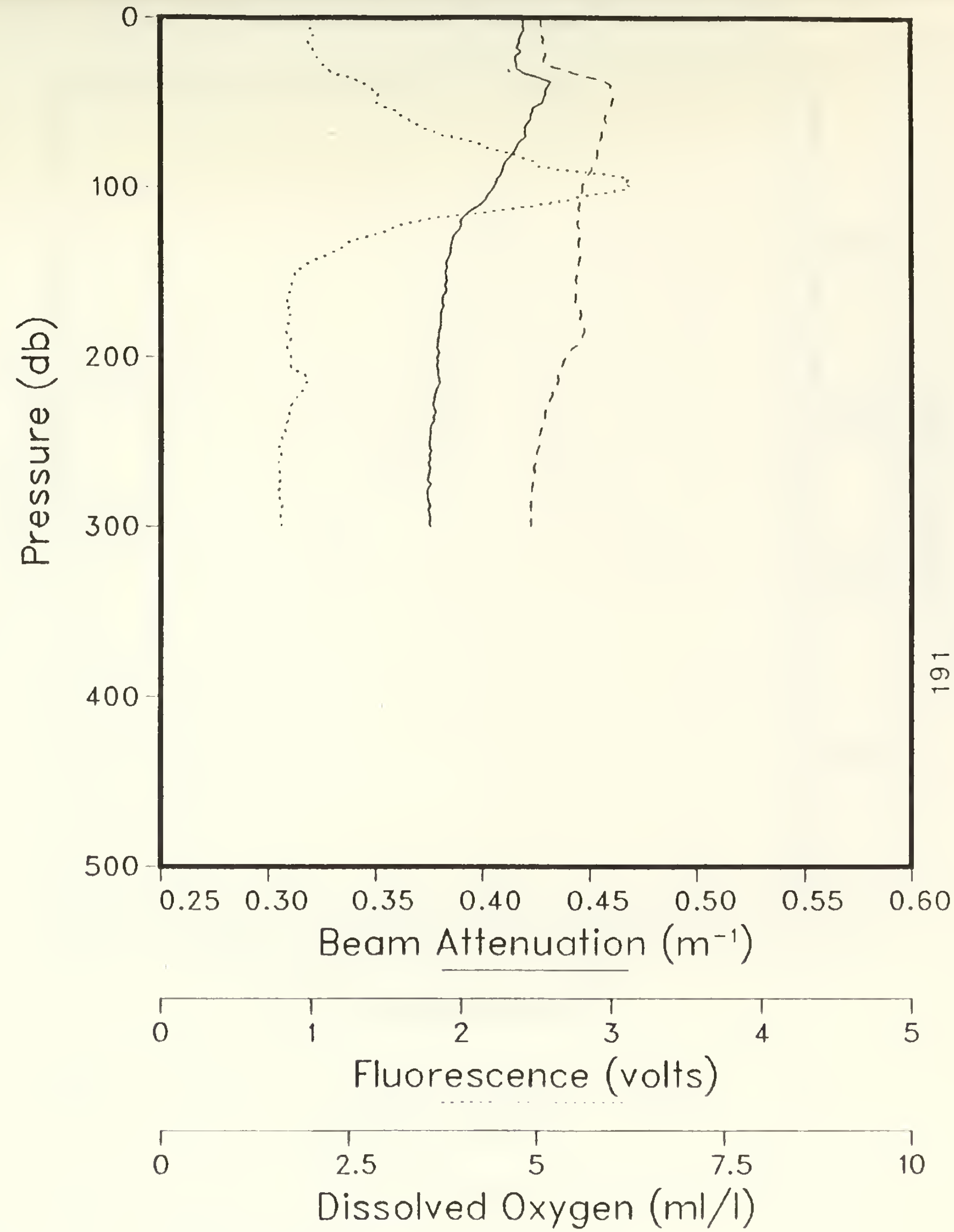


Latitude: 33.000°
Longitude: 142.367°

Date: 11/8/82
Time: 1223:20 GMT

R/V ACANIA CRUISE ODEX3 STATION 131

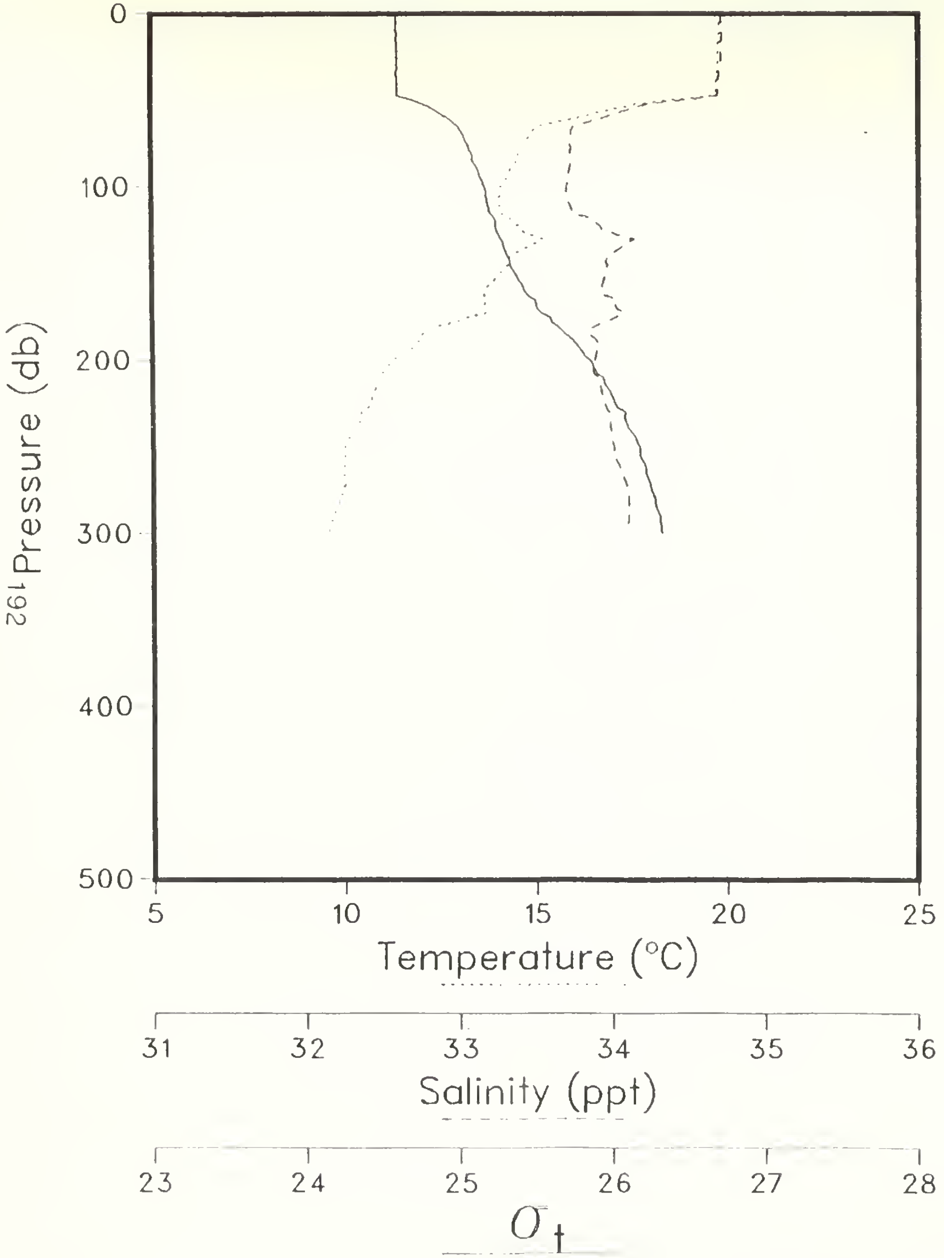


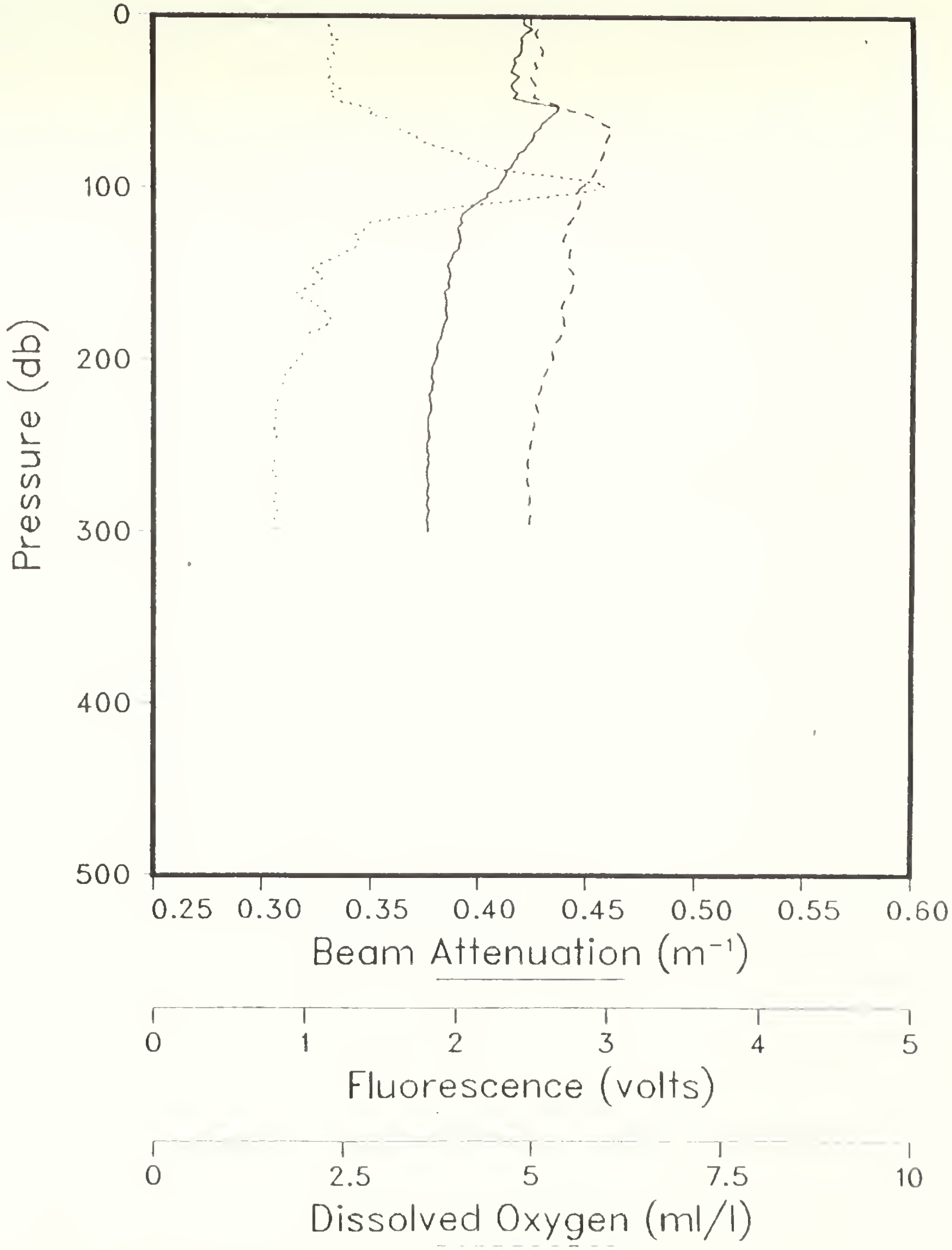


Latitude: 32.971°
Longitude: 142.257°

Date: 11/8/82
Time: 1404:24 GMT

R/V ACANIA CRUISE ODEX3 STATION 132

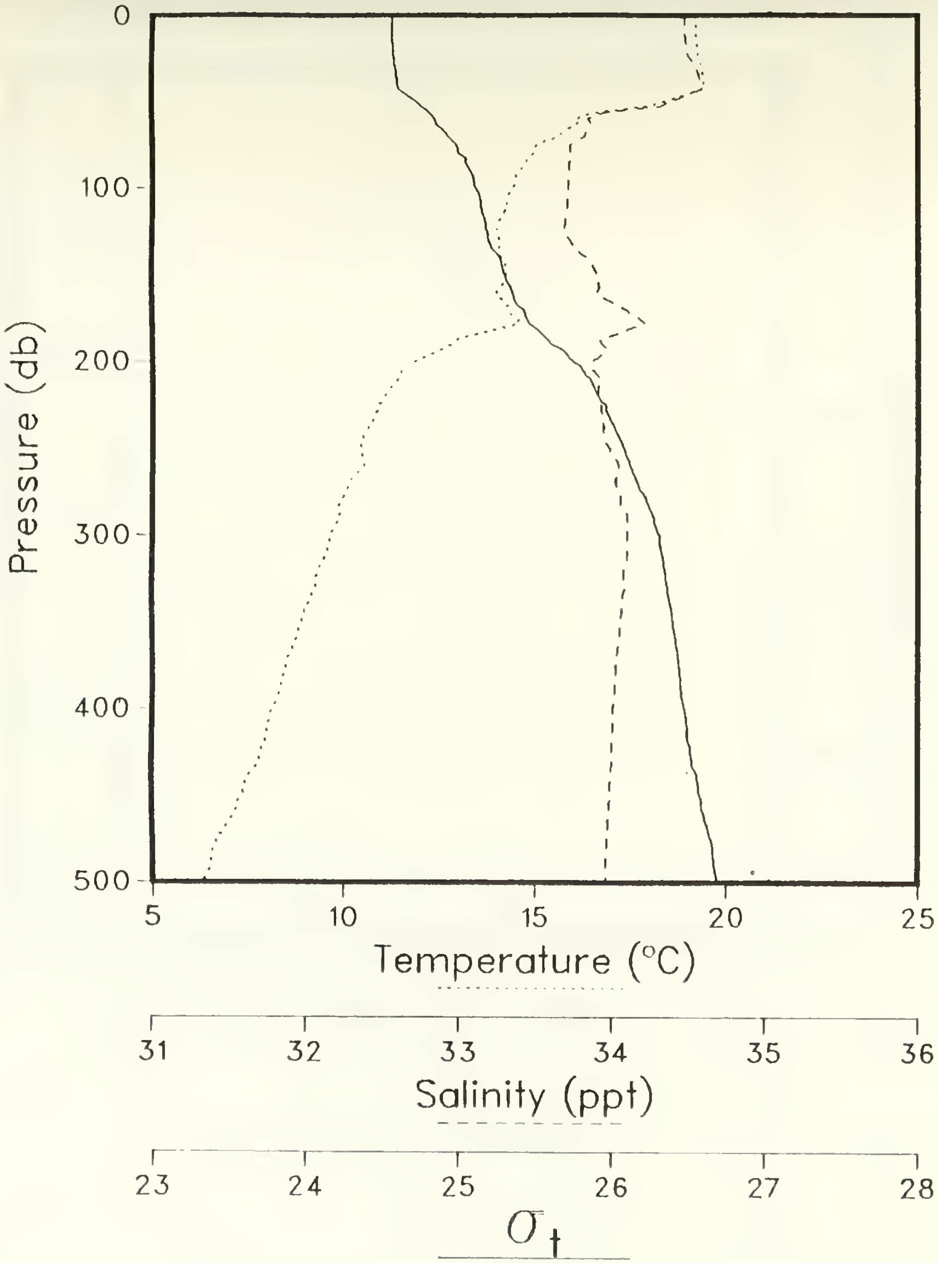


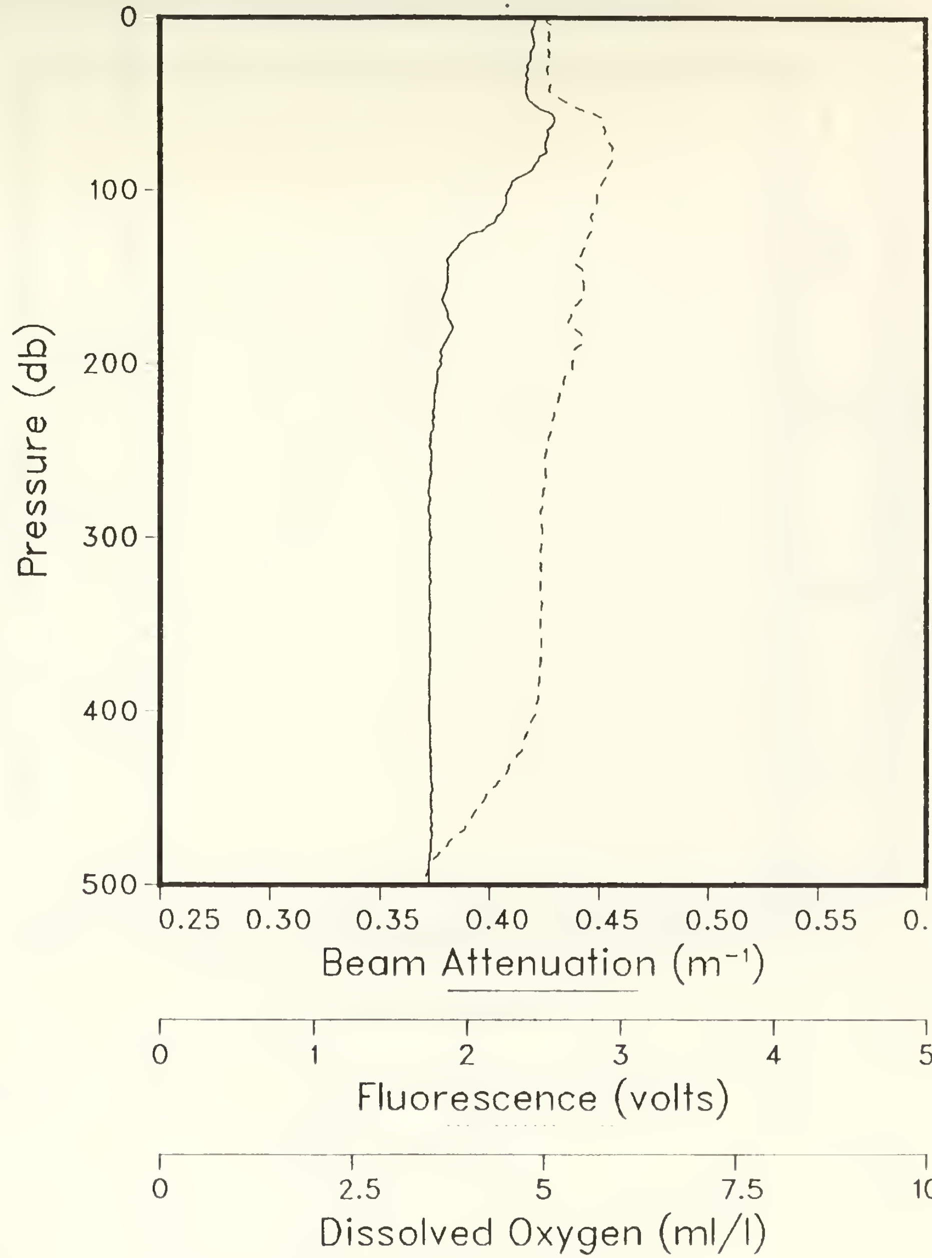


Latitude: 33.002°
Longitude: 142.089°

Date: 11/8/82
Time: 1616:09 GMT

R/V ACANIA CRUISE ODEX3 STATION 133

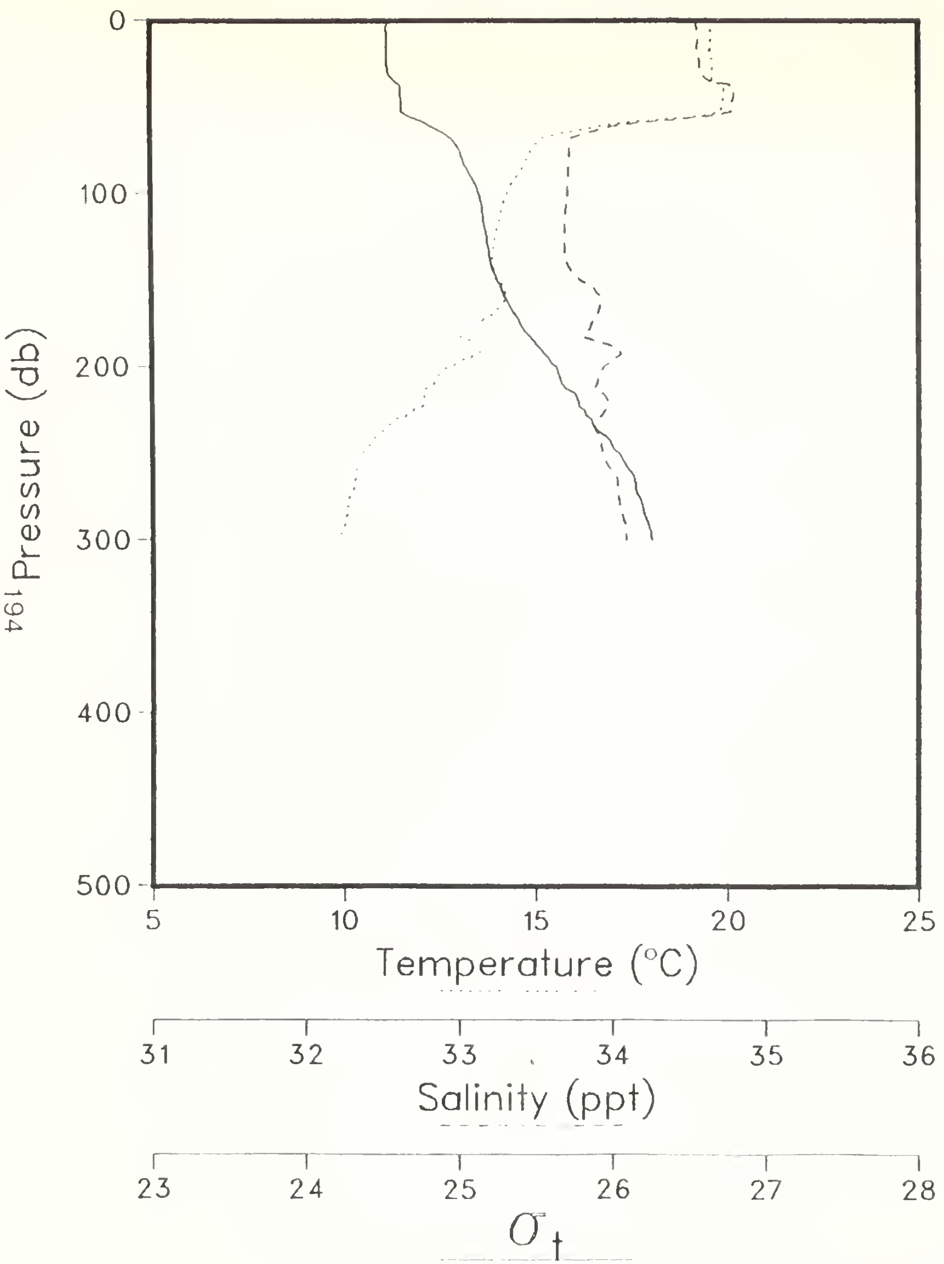


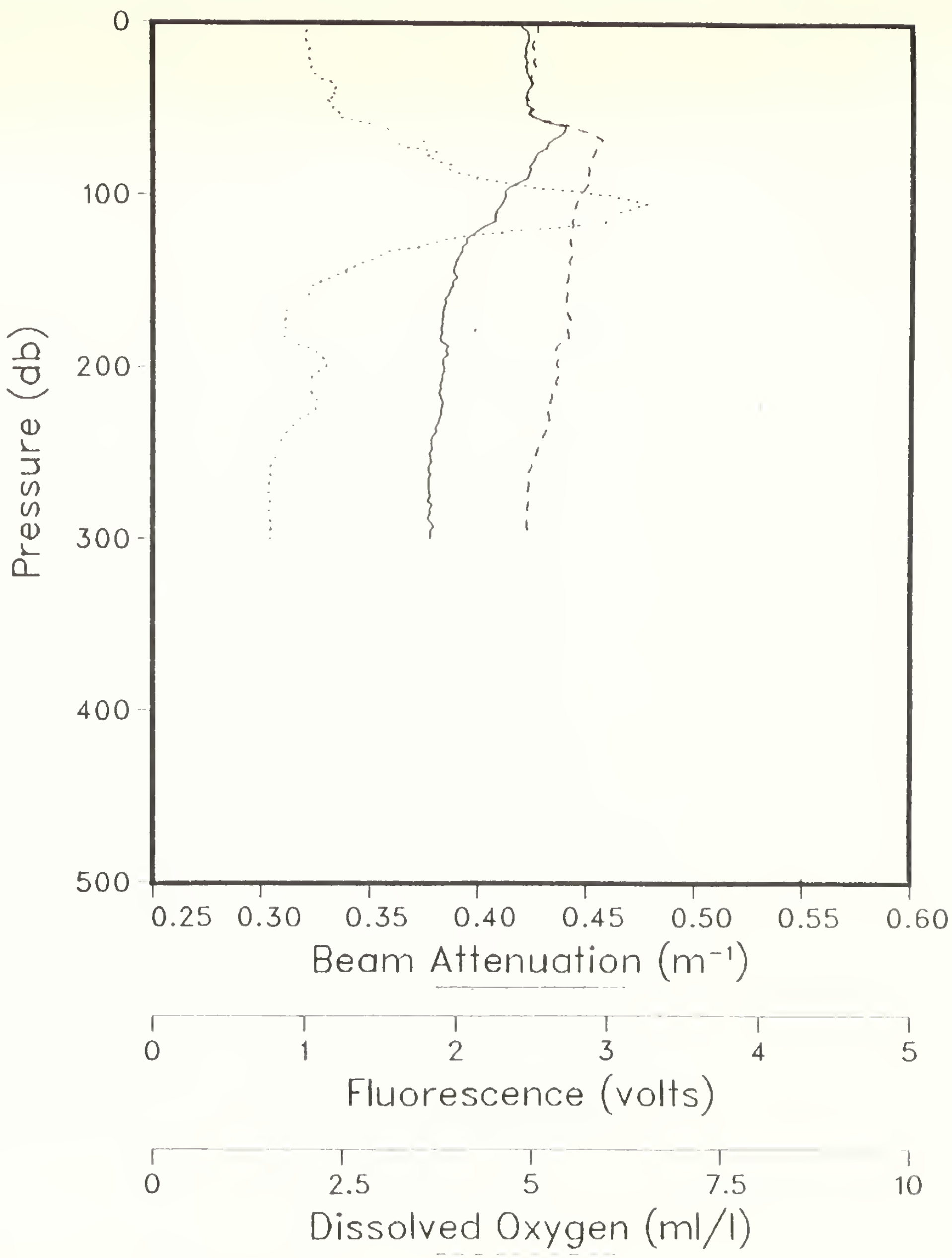


Latitude: 32.934°
Longitude: 142.085°

Date: 11/8/82
Time: 2011:12 GMT

R/V ACANIA CRUISE ODEX3 STATION 134

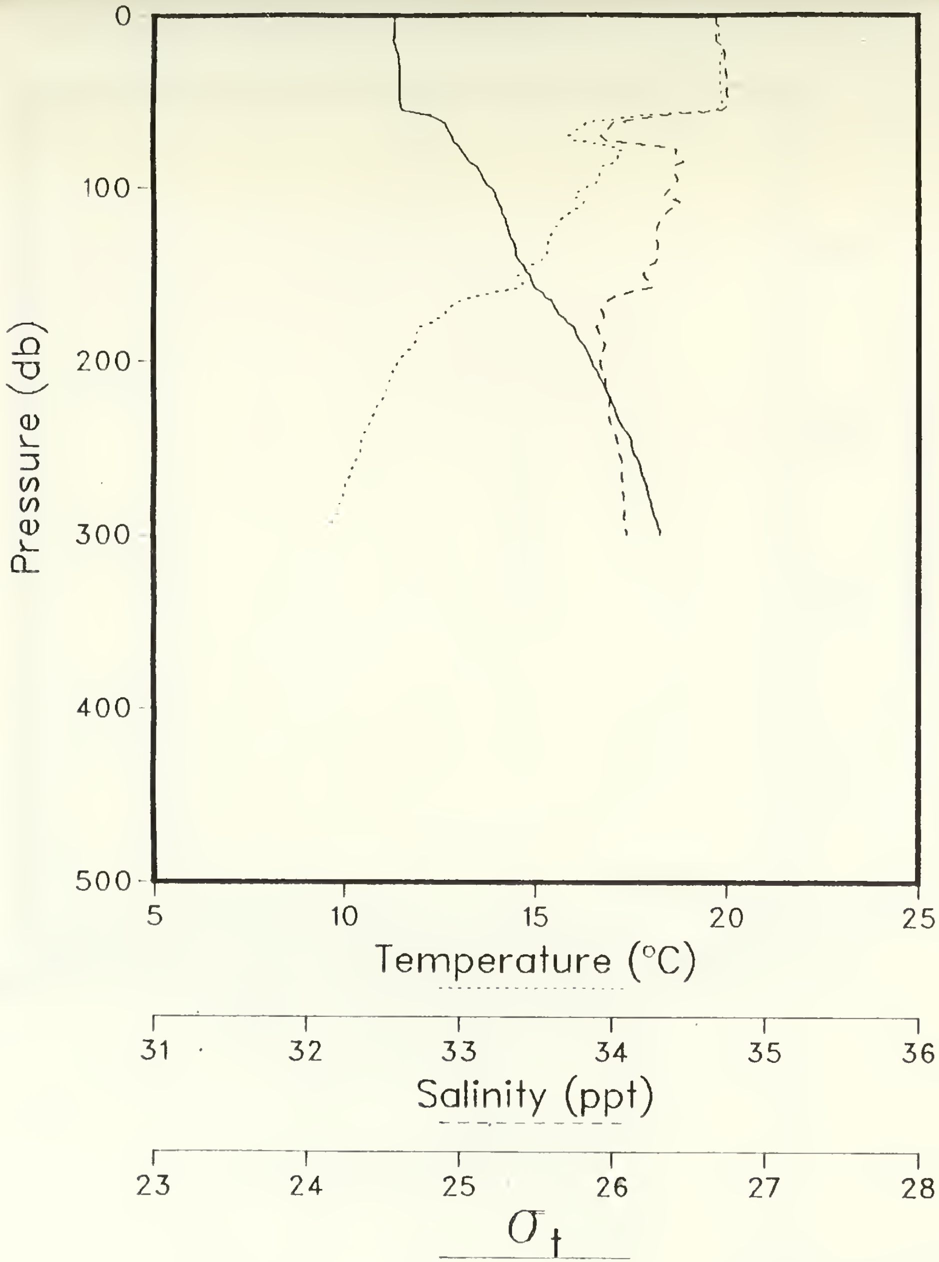


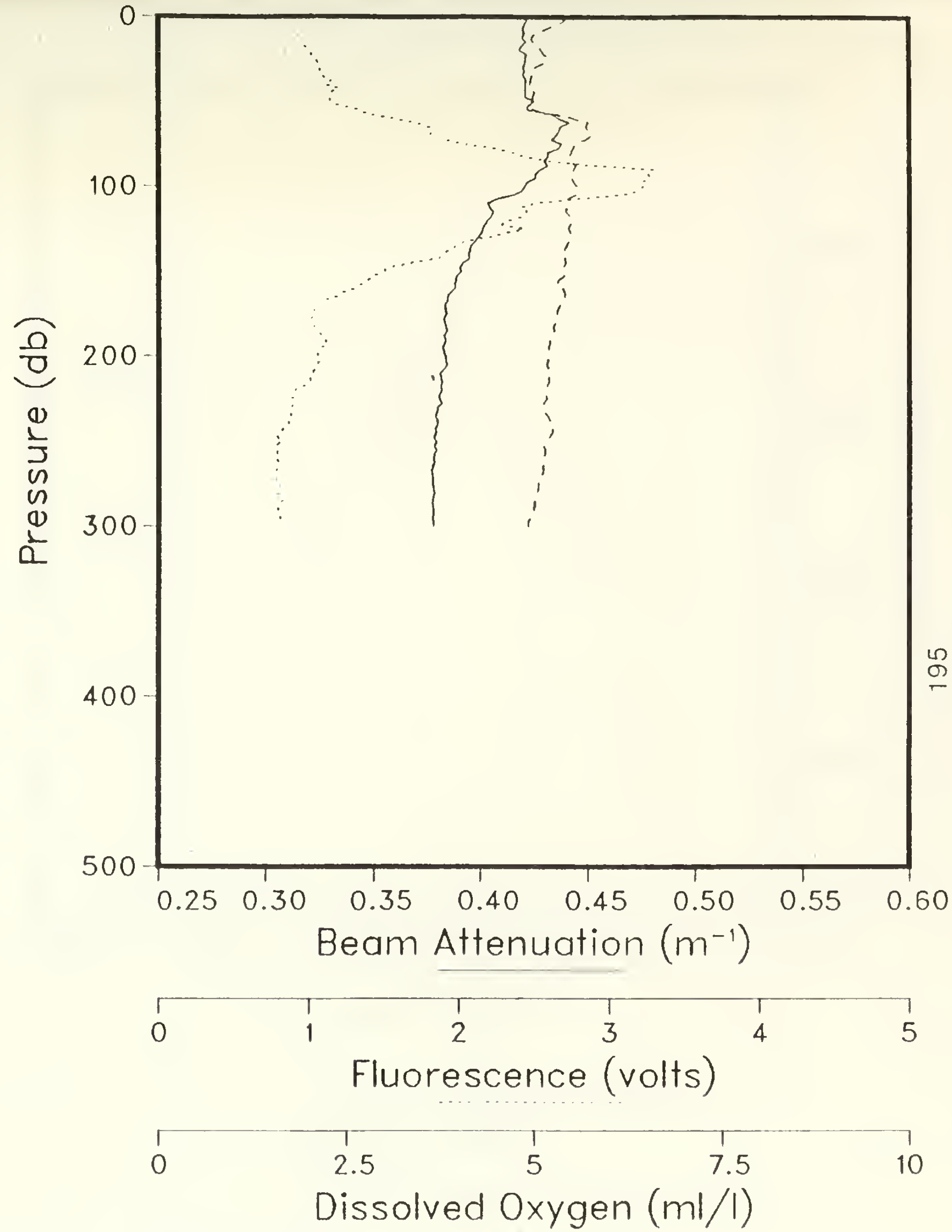


Latitude: 32.878°
Longitude: 142.522°

Date: 11/9/82
Time: 506:21 GMT

R/V ACANIA CRUISE ODEX3 STATION 135

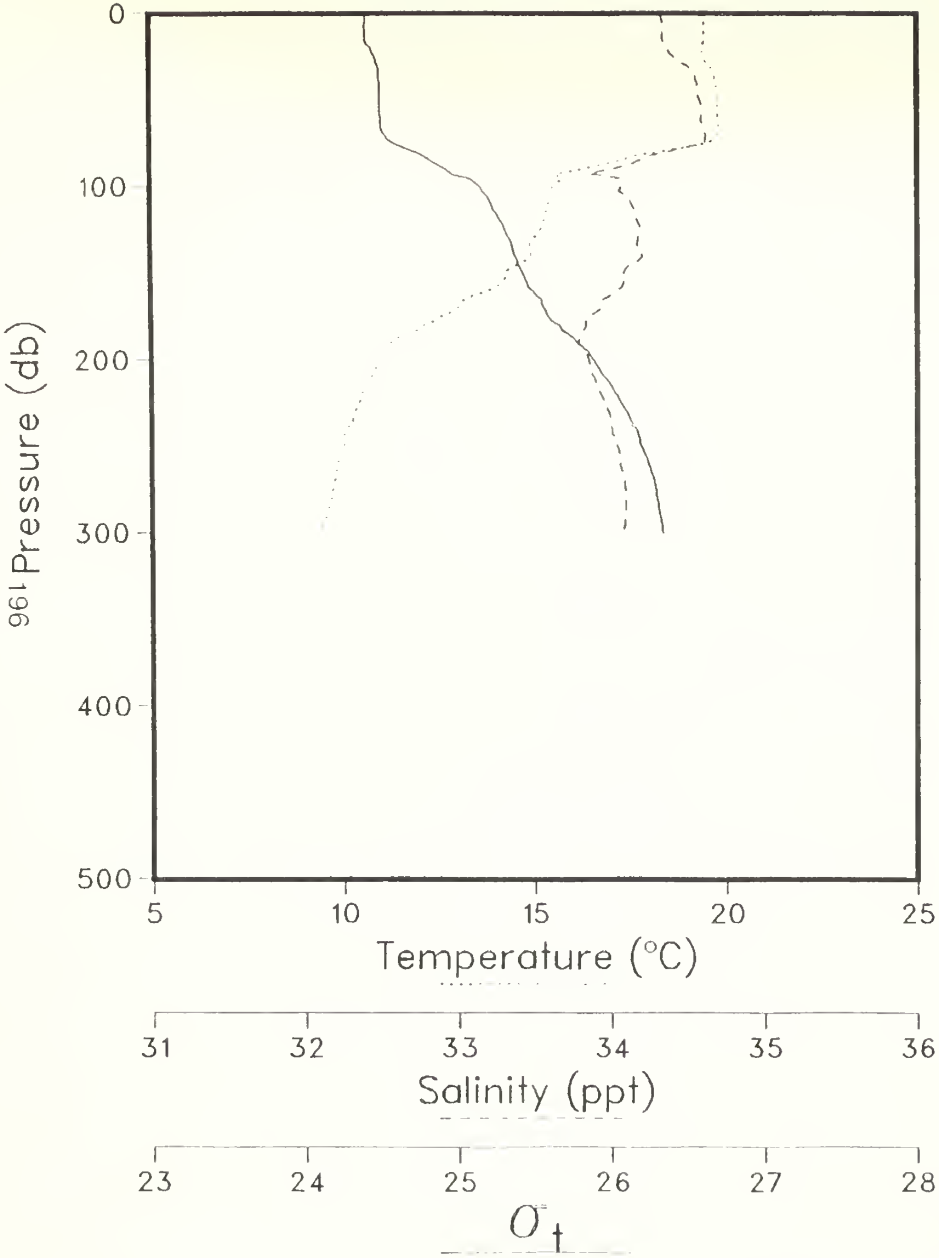


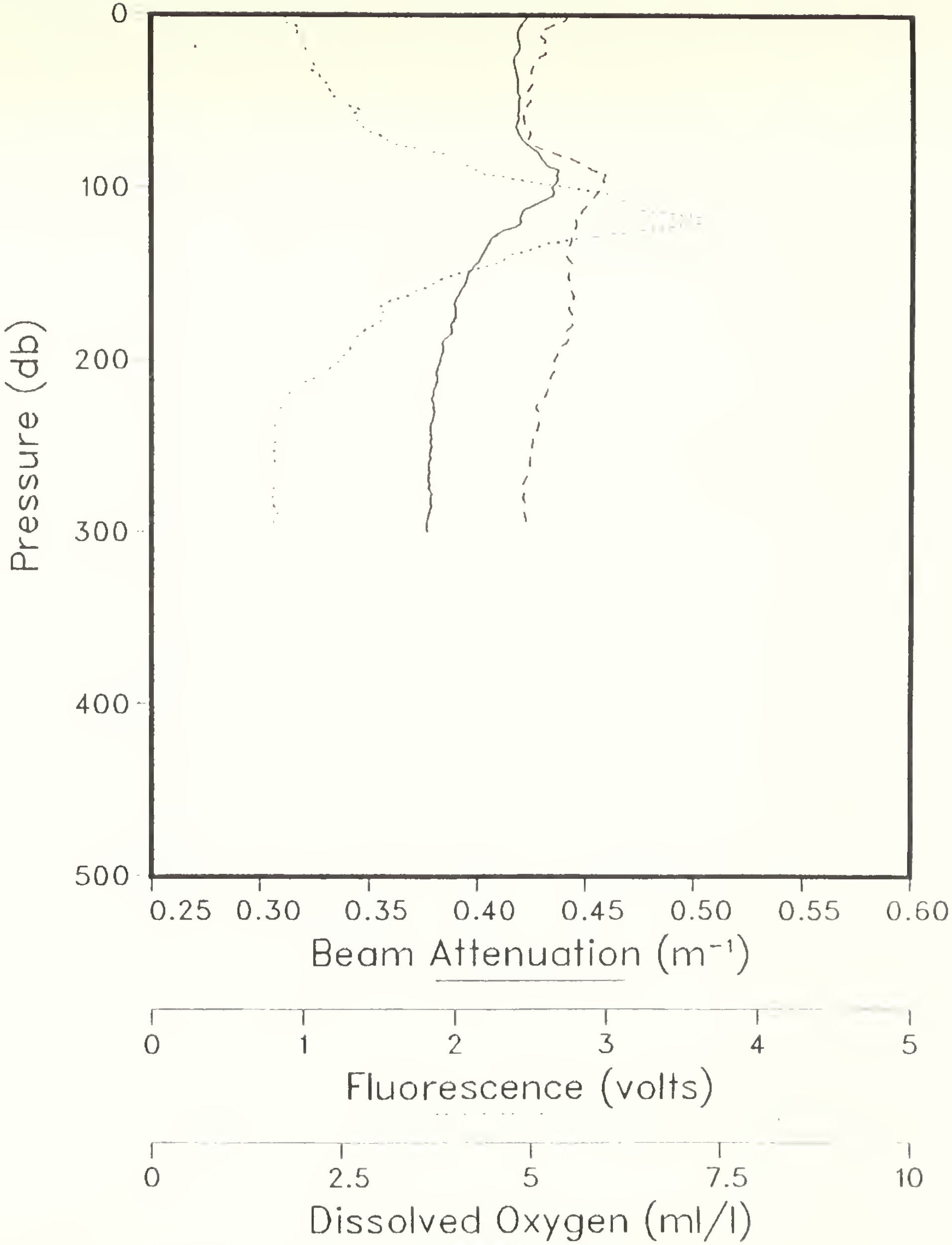


Latitude: 32.767°
Longitude: 142.500°

Date: 11/9/82
Time: 640:02 GMT

R/V ACANIA CRUISE ODEX3 STATION 136

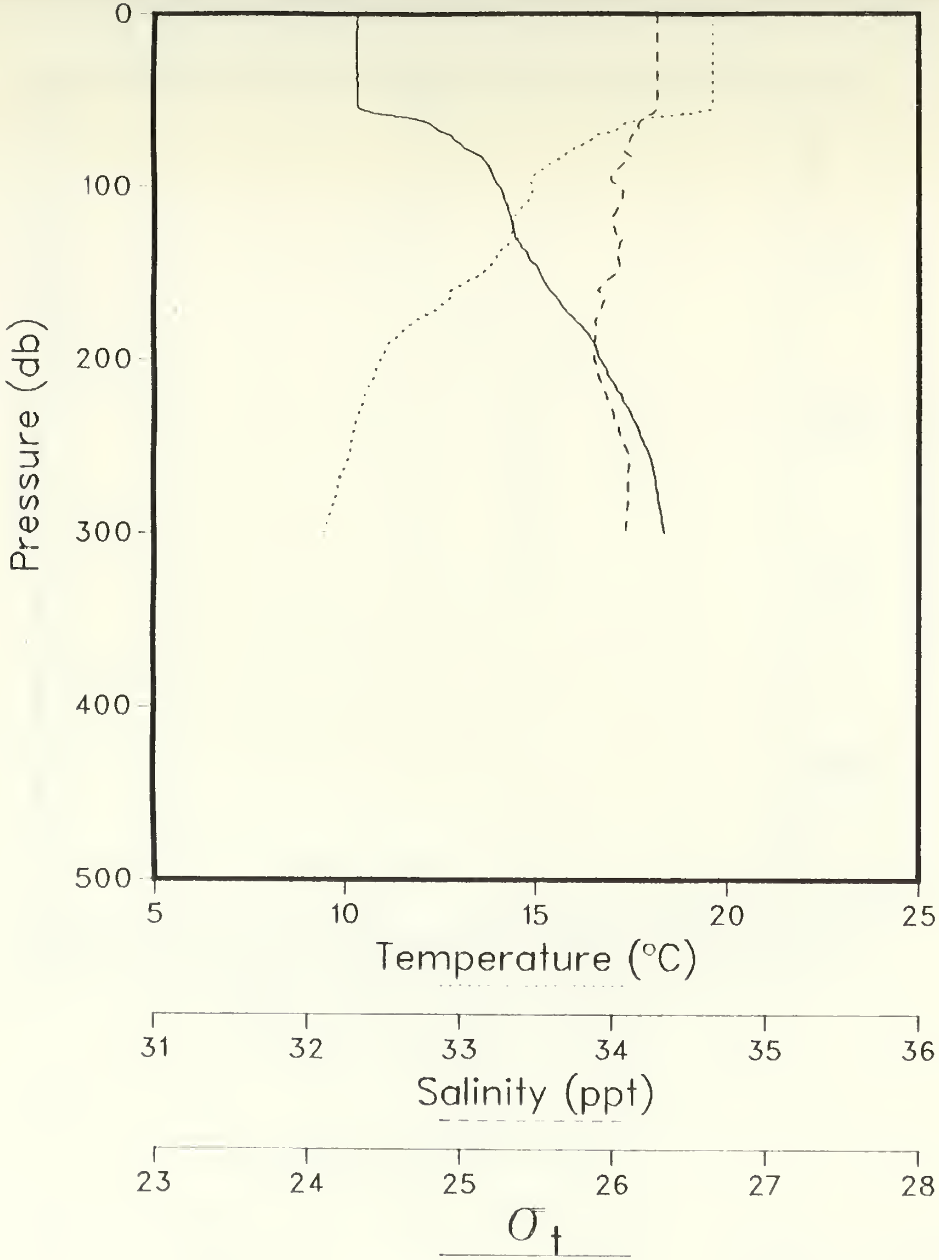


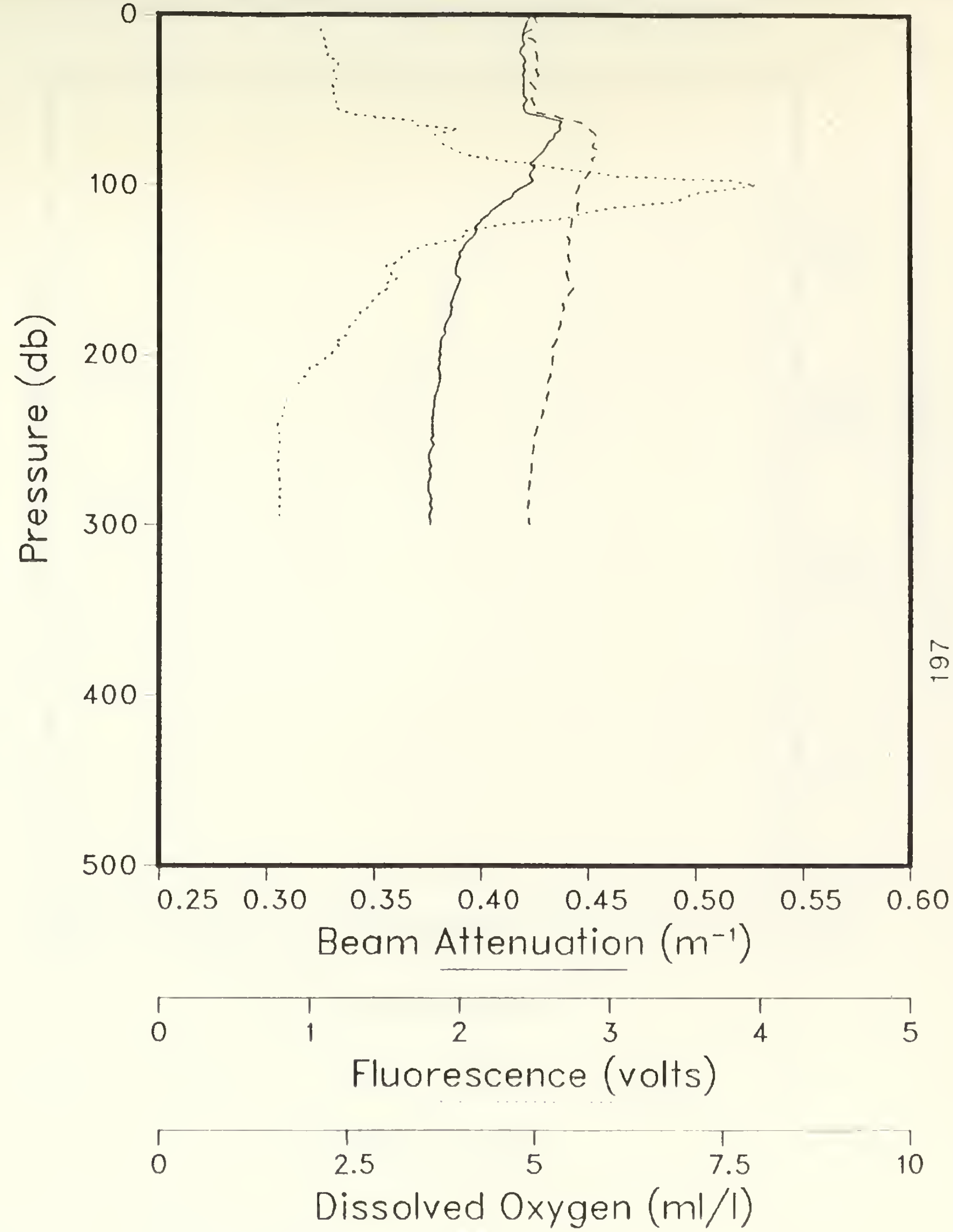


Latitude: 32.632°
Longitude: 142.503°

Date: 11/9/82
Time: 808:51 GMT

R/V ACANIA CRUISE ODEX3 STATION 137

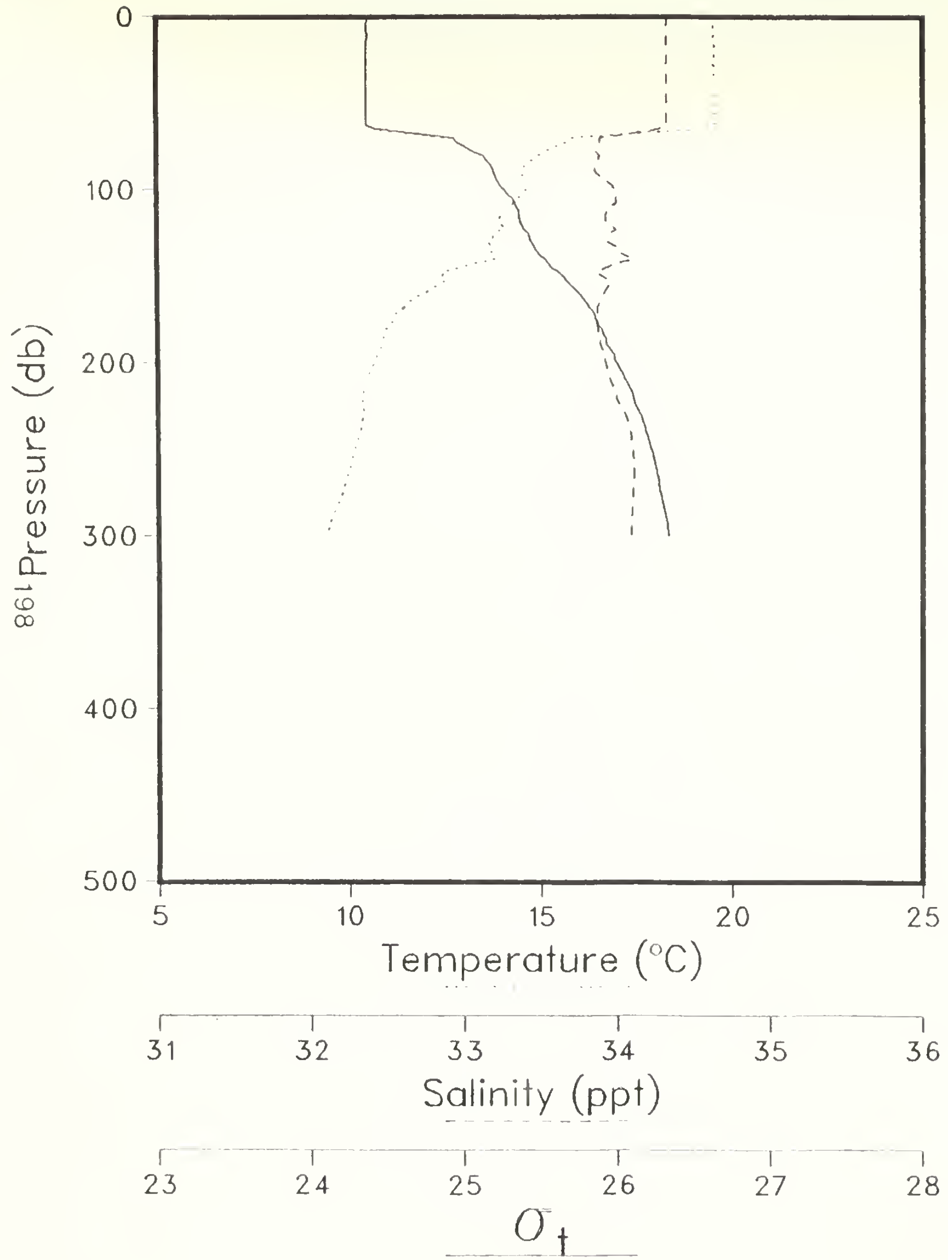


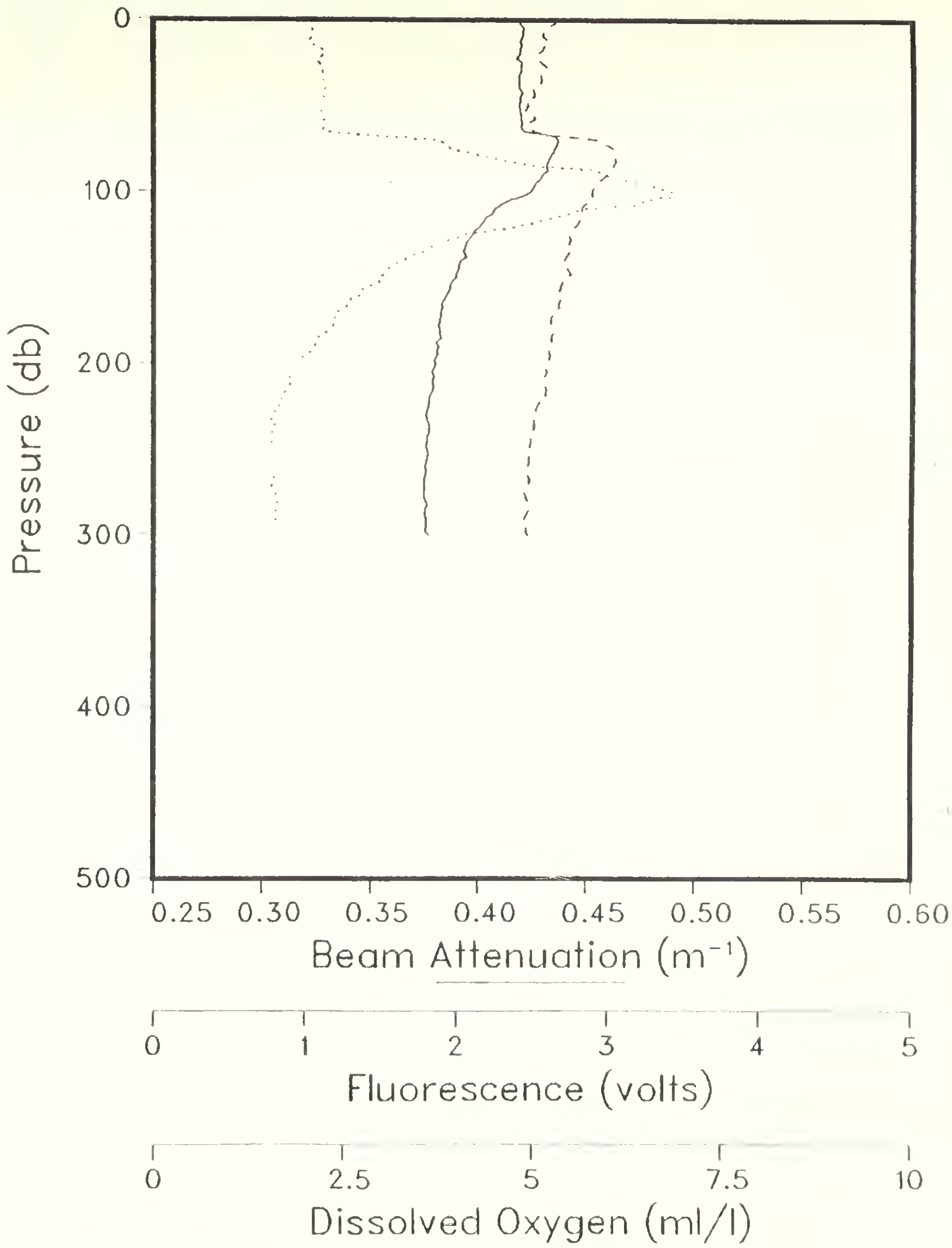


Latitude: 32.533°
Longitude: 142.500°

Date: 11/9/82
Time: 947:00 GMT

R/V ACANIA CRUISE ODEX3 STATION 138

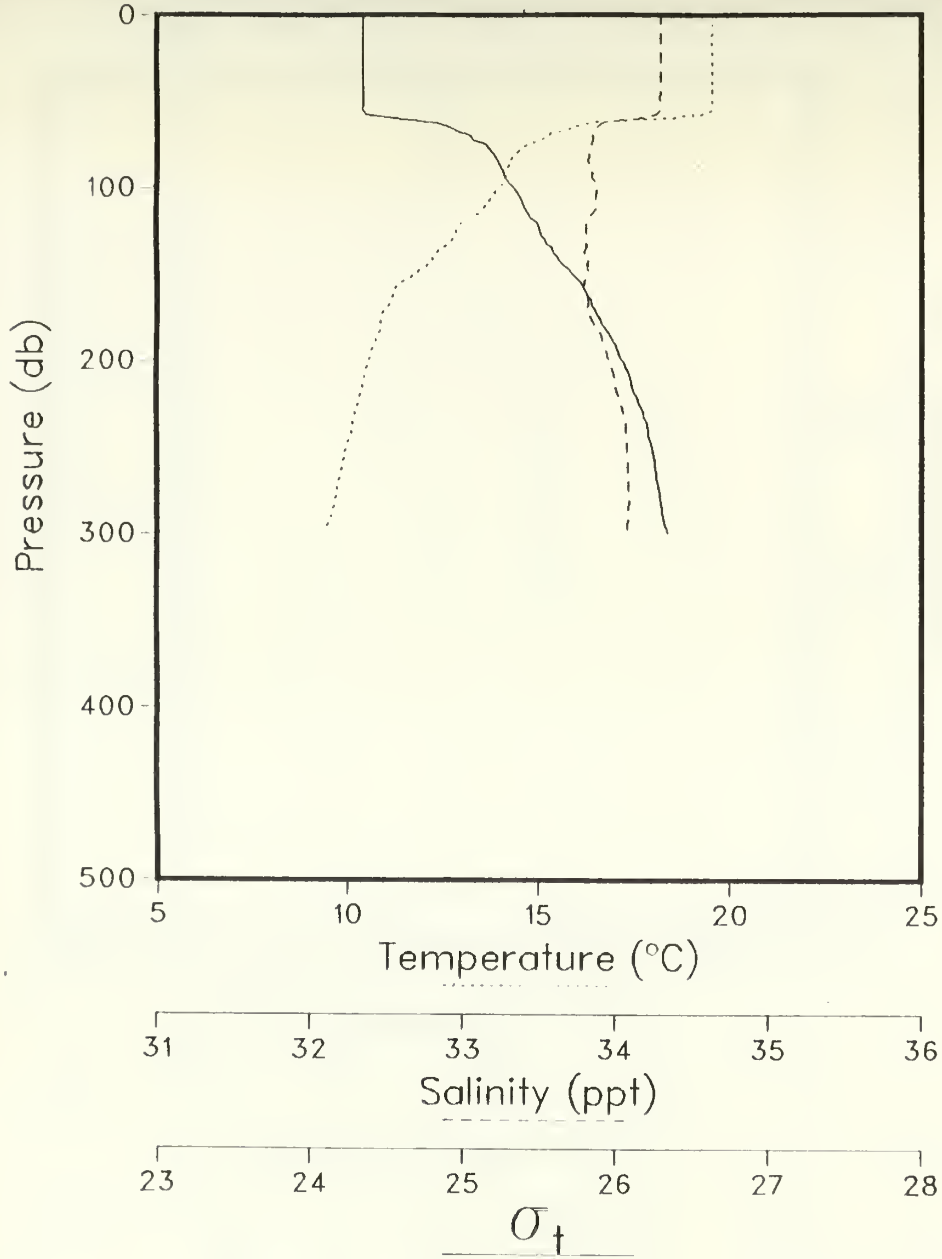


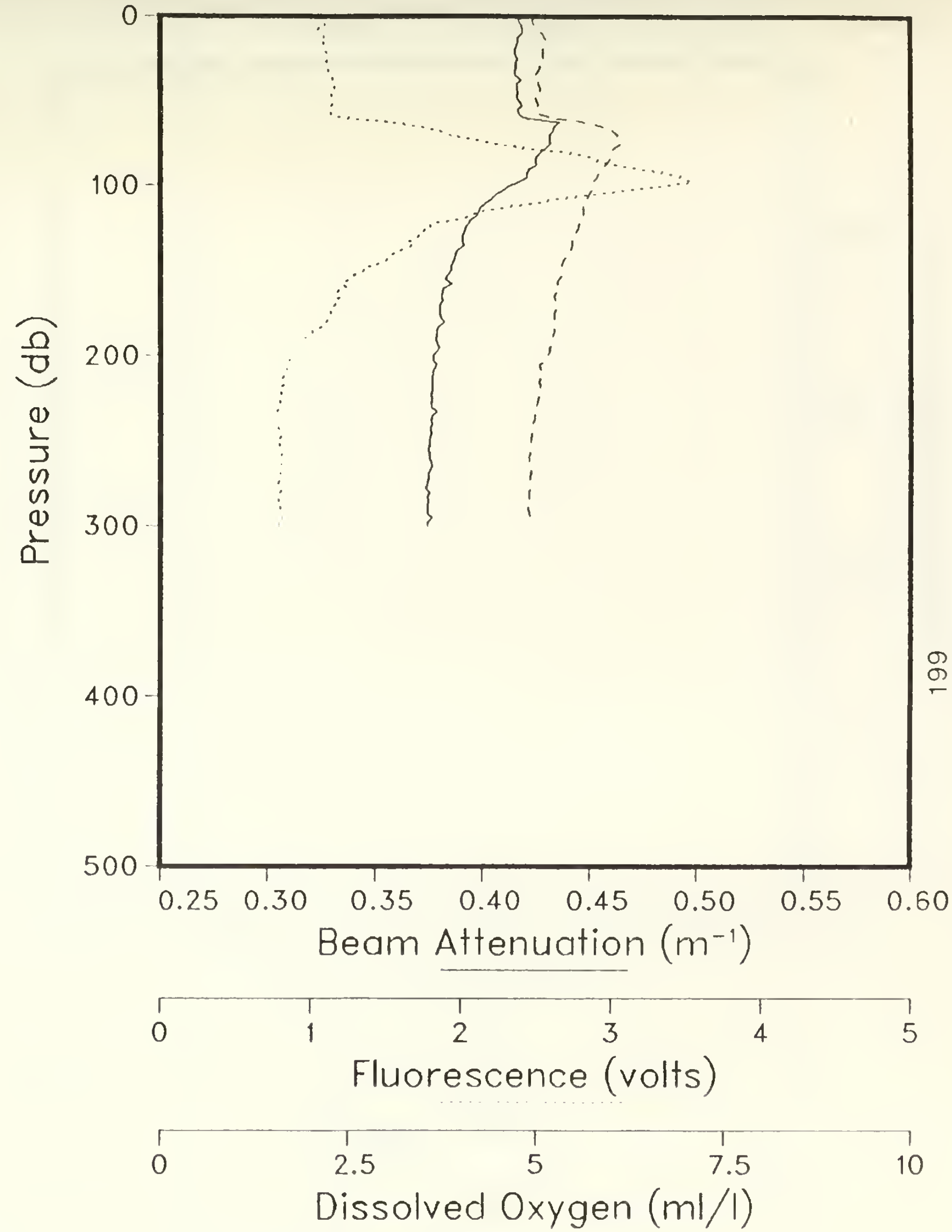


Latitude: 32.417°
Longitude: 142.500°

Date: 11/9/82
Time: 1115:33 GMT

R/V ACANIA CRUISE ODEX3 STATION 139

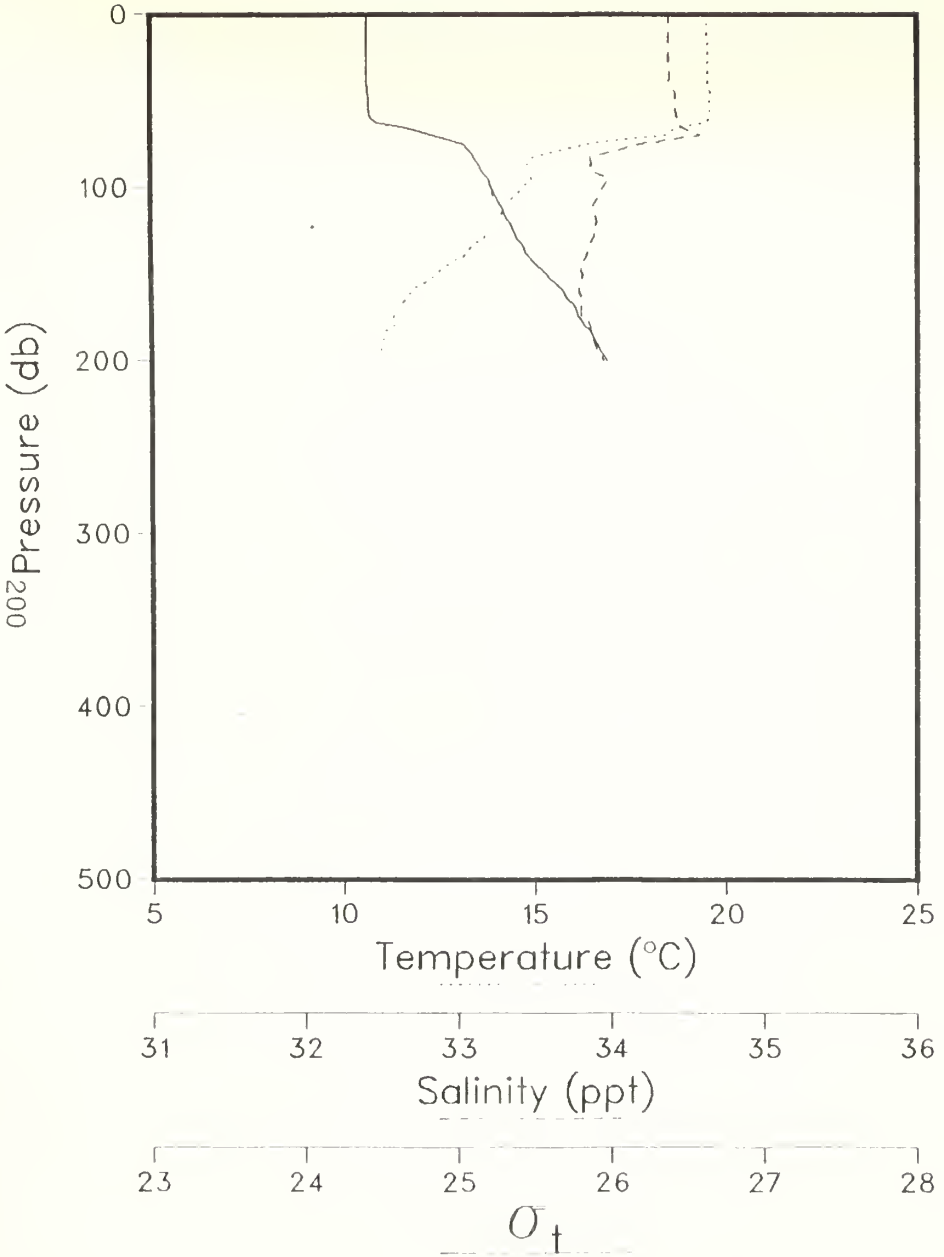


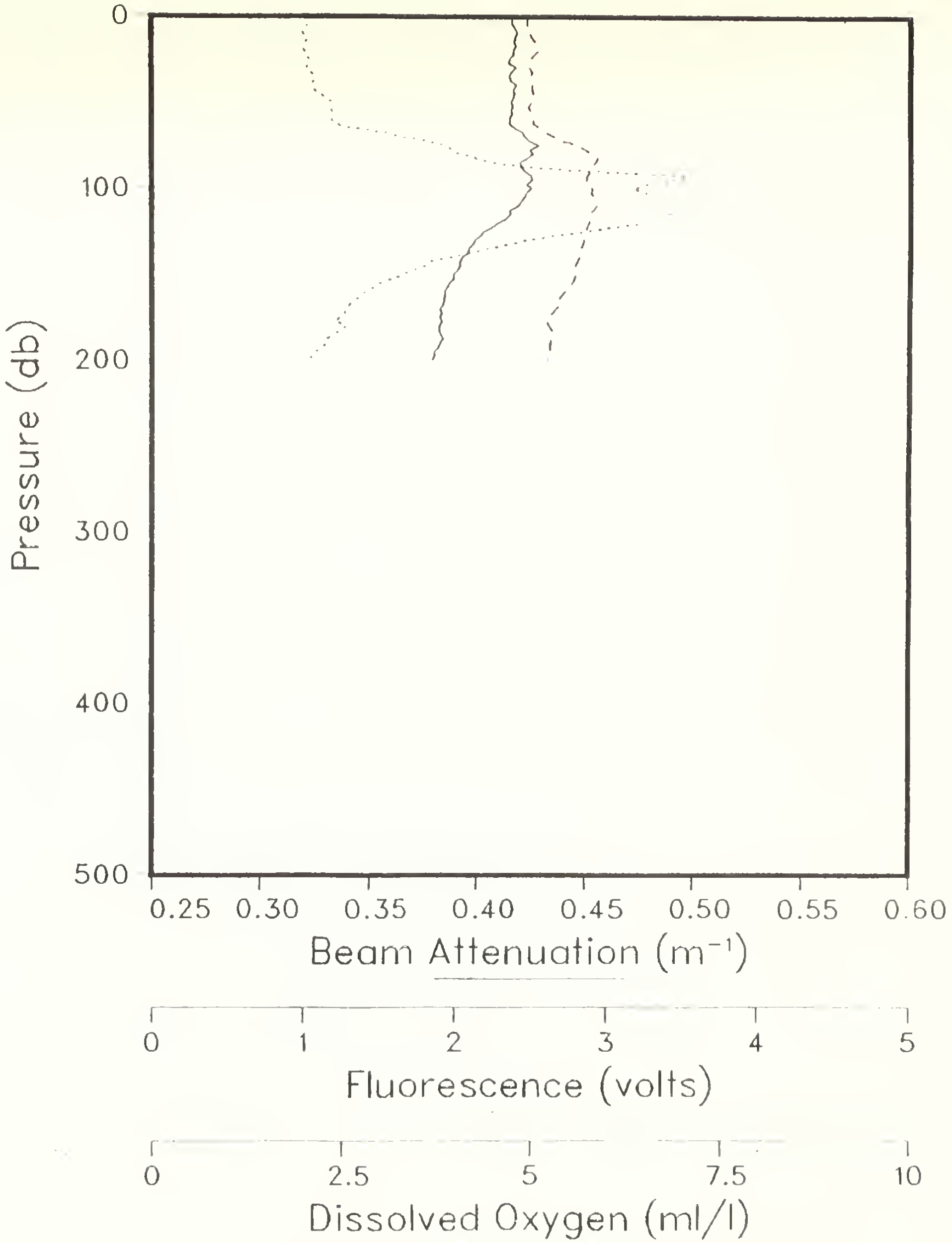


Latitude: 32.300°
Longitude: 142.500°

Date: 11/9/82
Time: 1250:20 GMT

R/V ACANIA CRUISE ODEX3 STATION 140

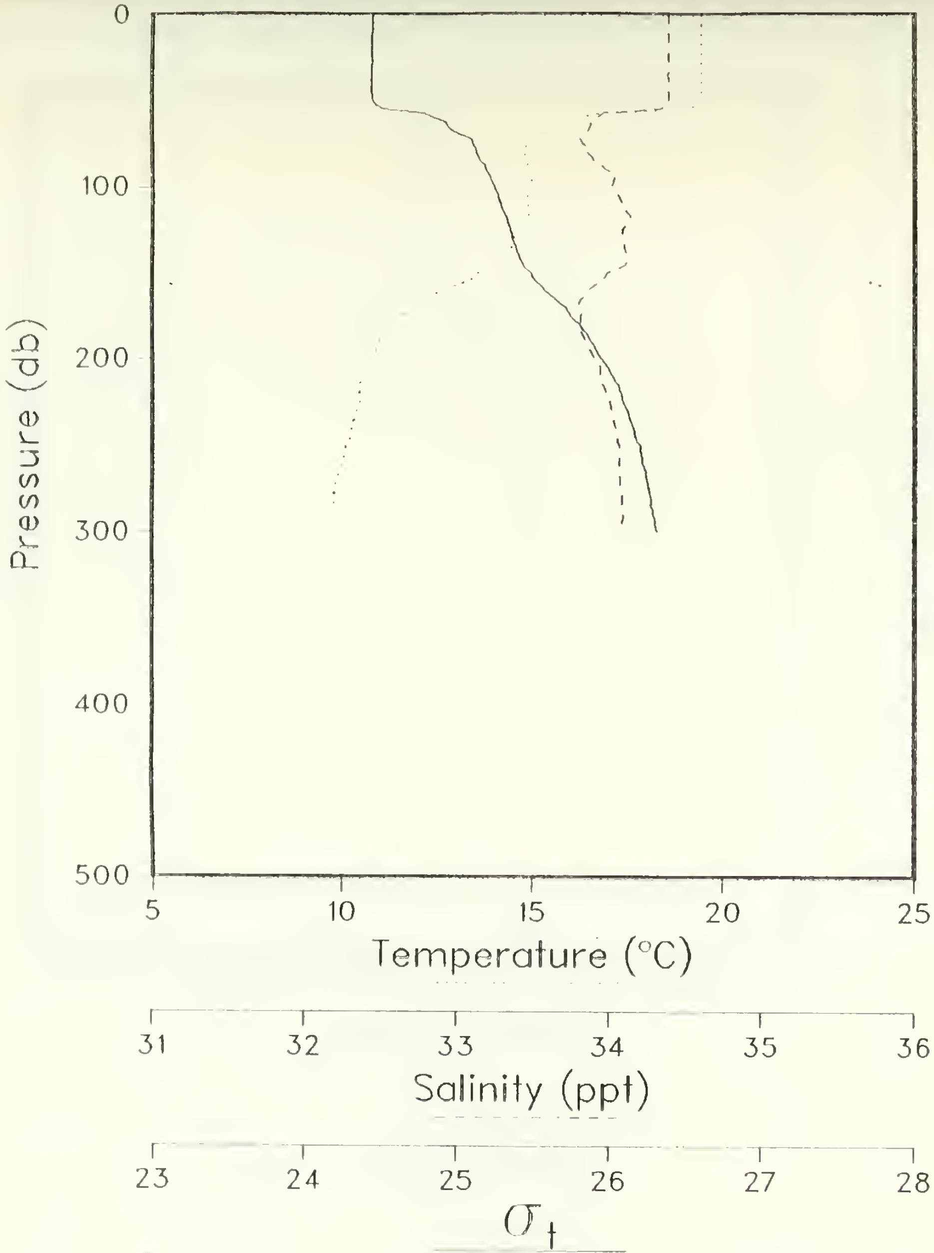


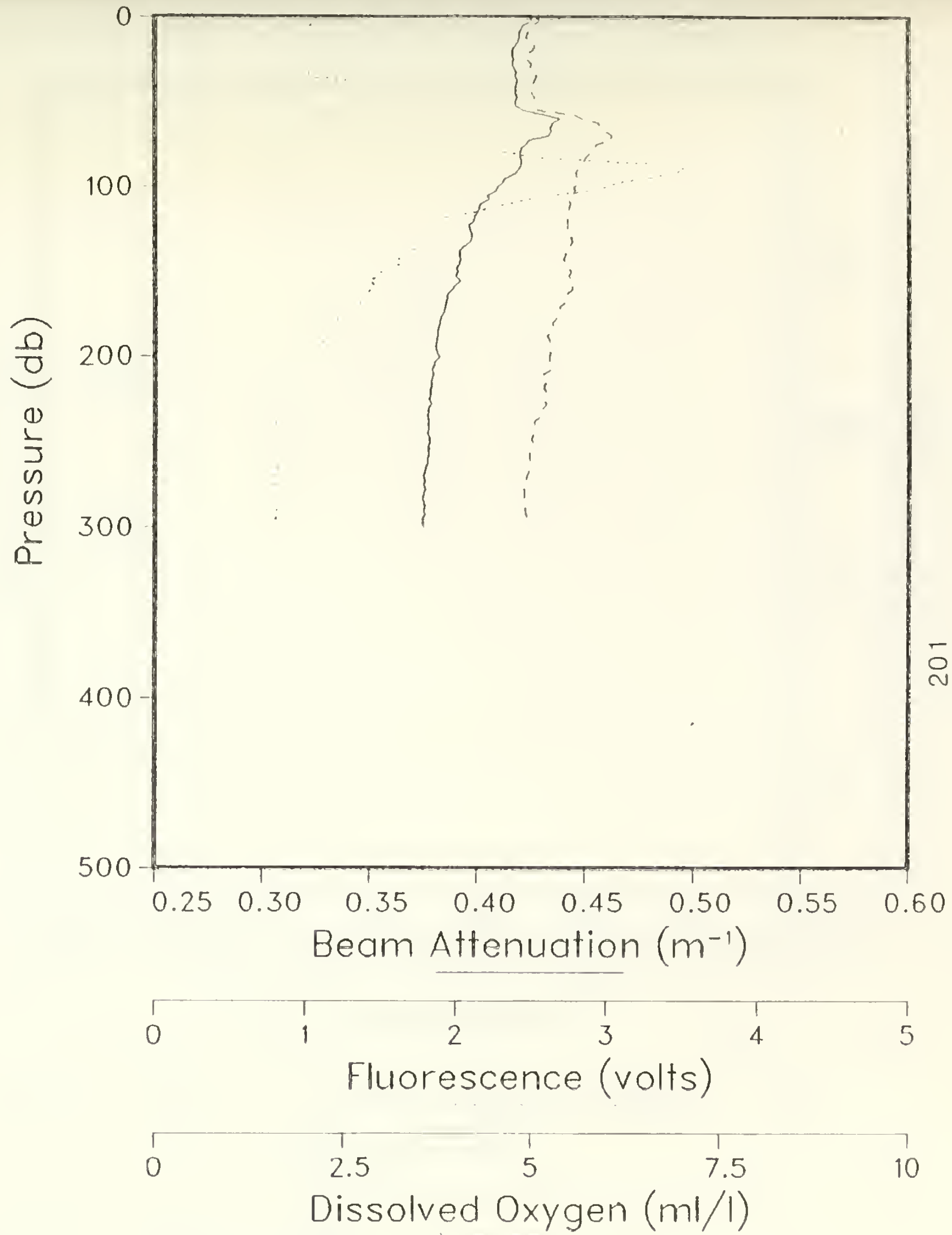


Latitude: 32.183°
Longitude: 142.500°

Date: 11/9/82
Time: 1429:24 GMT

R/V ACANIA CRUISE ODEX3 STATION 141

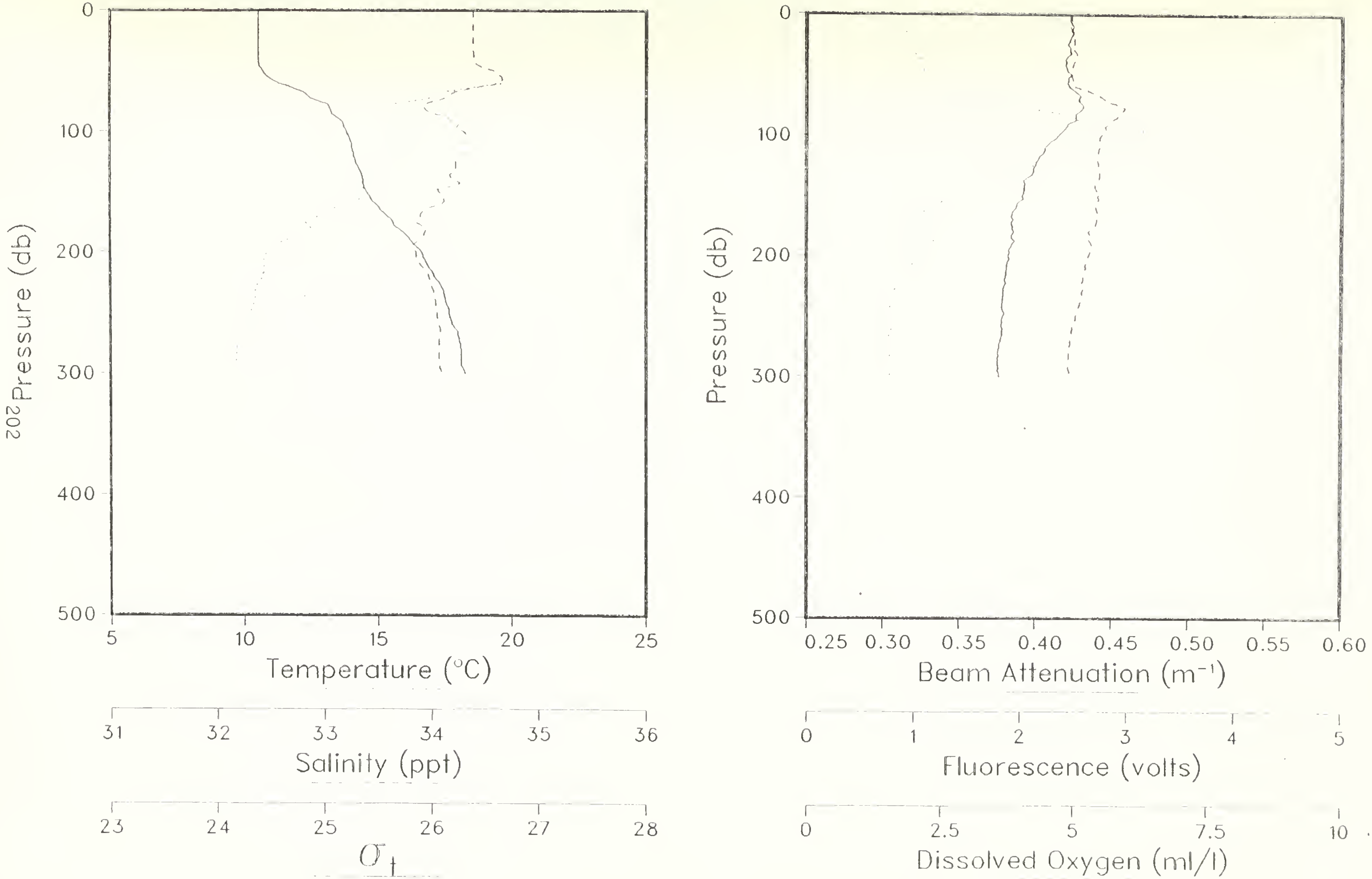




Latitude: 32.162°
Longitude: 142.617°

Date: 11/9/82
Time: 1606:51 GMT

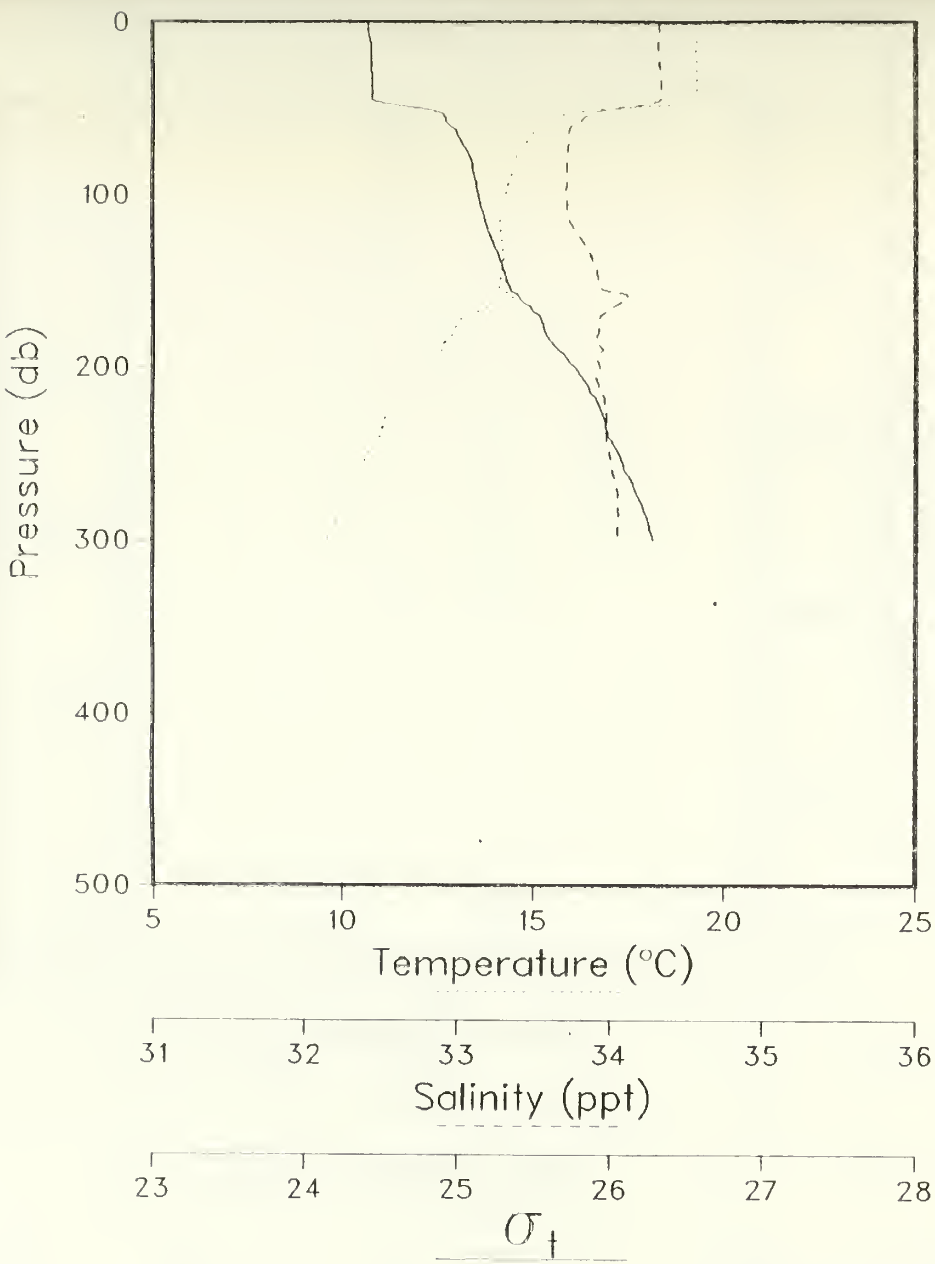
R/V ACANIA CRUISE ODEX3 STATION 142

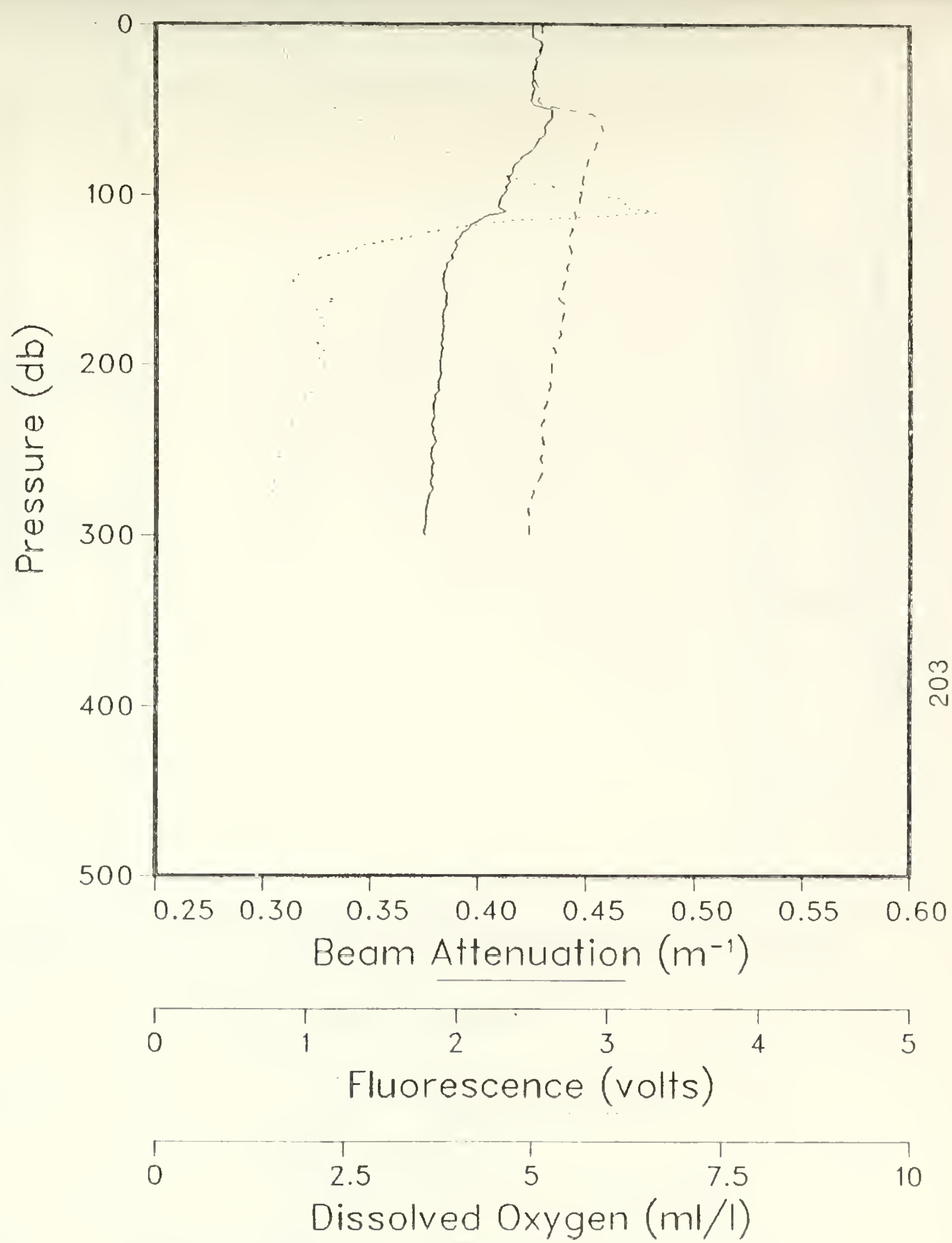


Latitude: 32.182°
Longitude: 142.778°

Date: 11/9/82
Time: 1843:25 GMT

R/V ACANIA CRUISE ODEX3 STATION 143

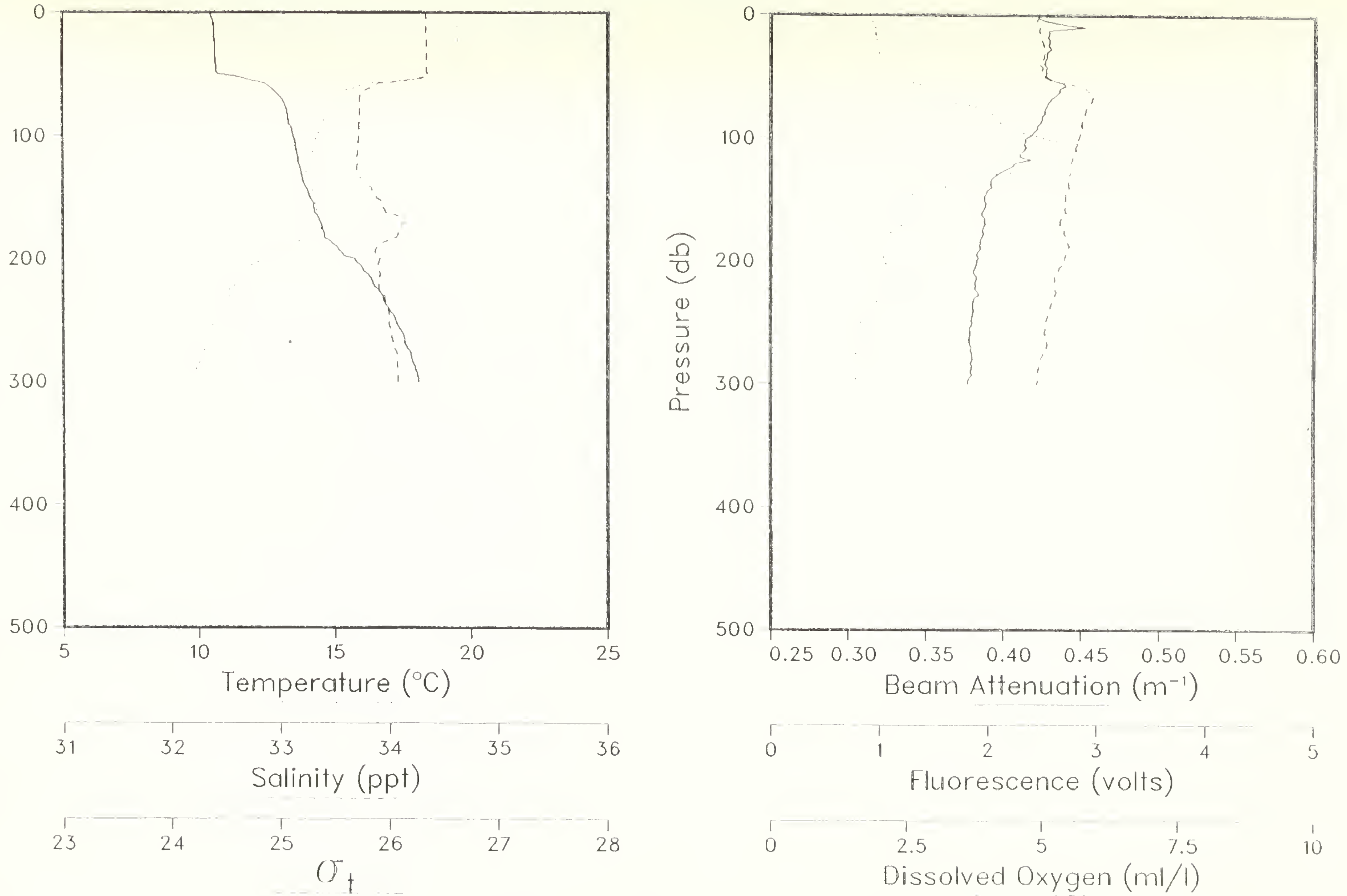




Latitude: 32.123°
Longitude: 142.935°

Date: 11/9/82
Time: 2134:52 GMT

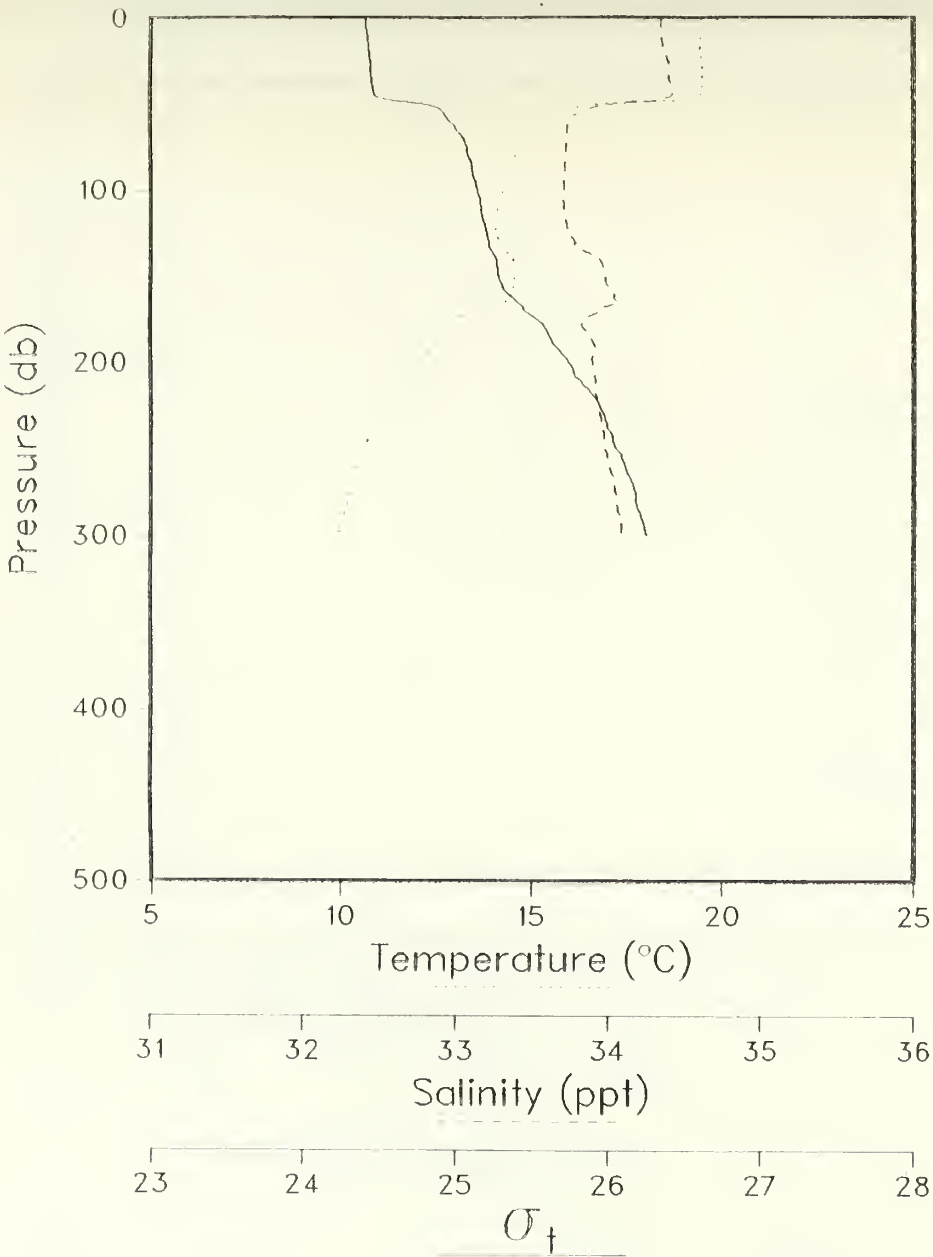
R/V ACANIA CRUISE ODEX3 STATION 144

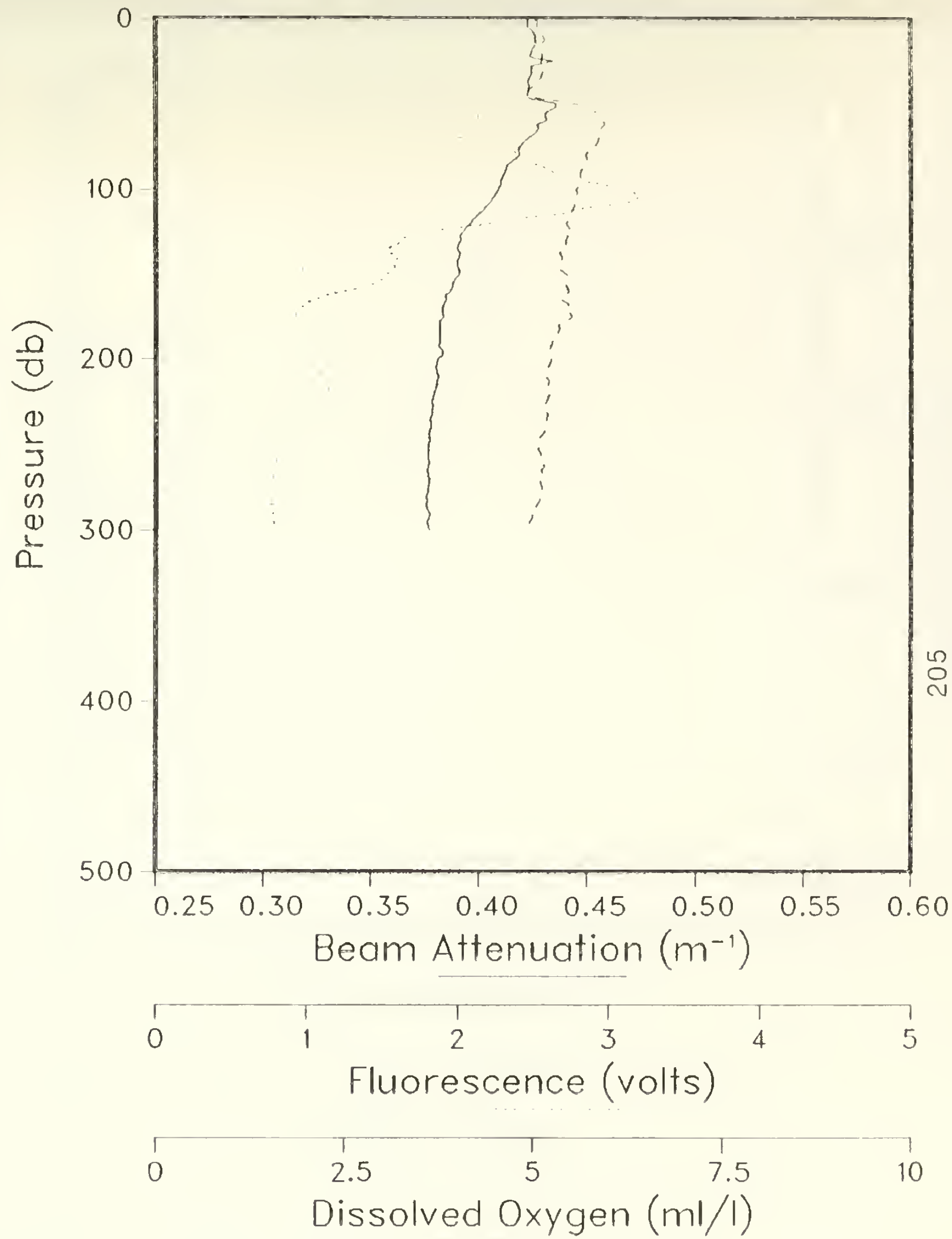


Latitude: 32.263°
Longitude: 142.968°

Date: 11/10/82
Time: 108:32 GMT

R/V ACANIA CRUISE ODEX3 STATION 145

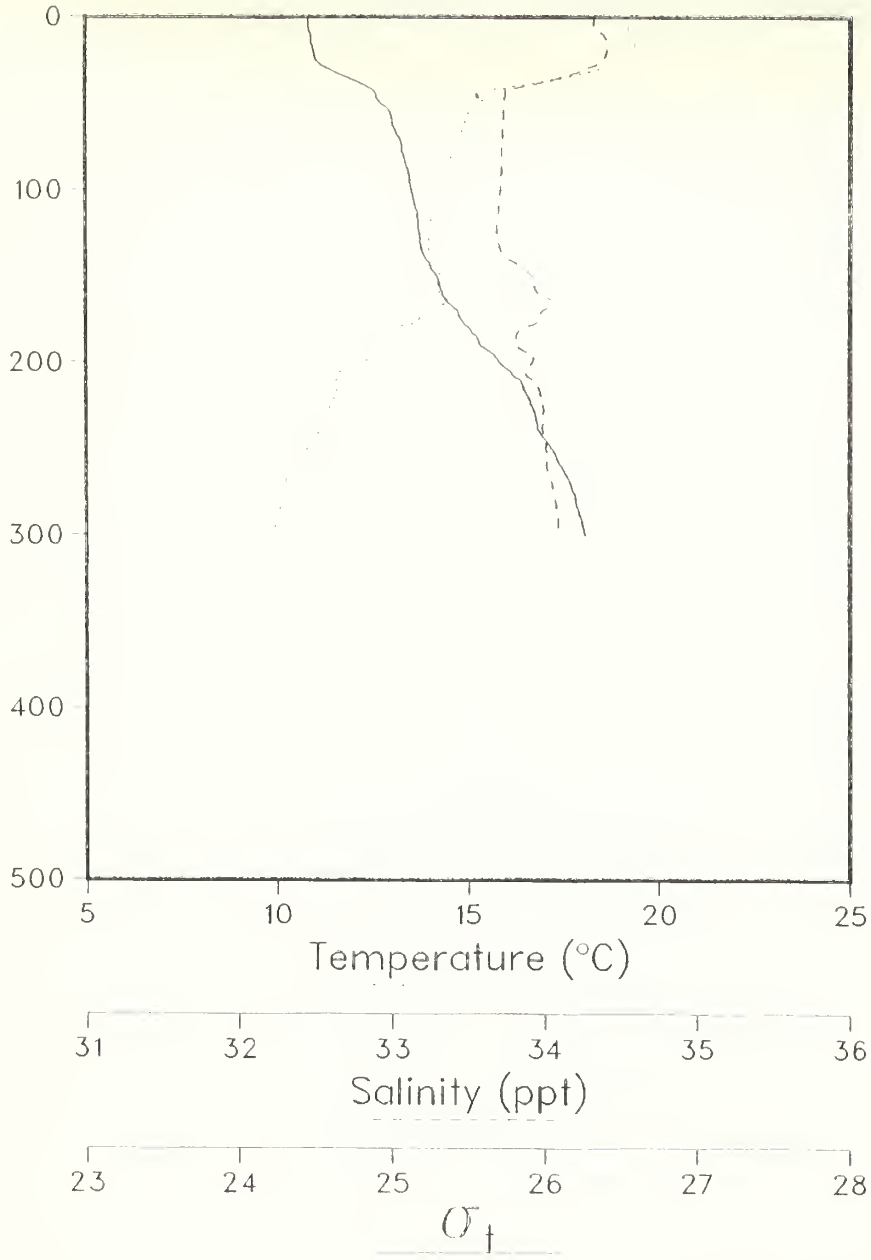


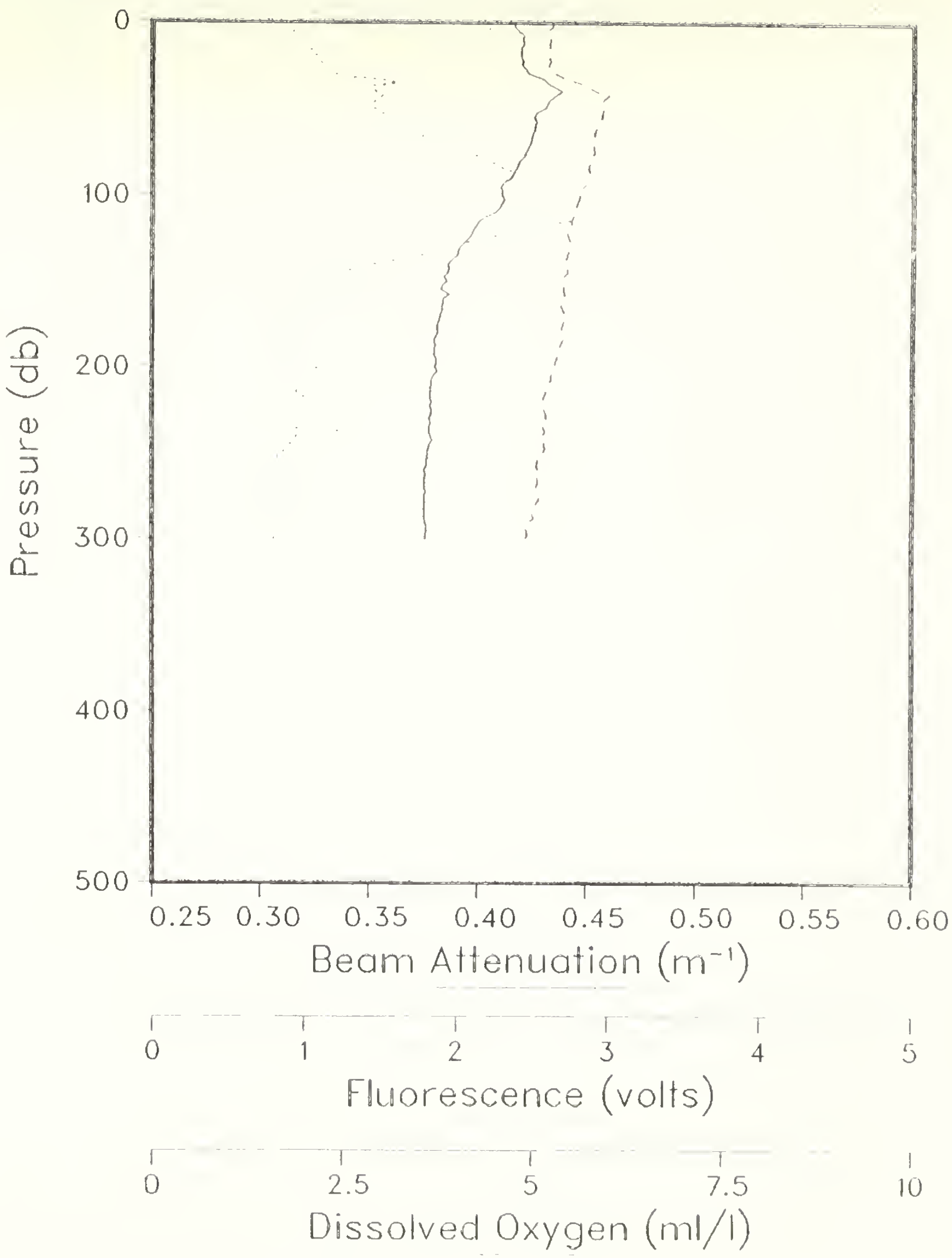


Latitude: 32.417°
Longitude: 142.917°

Date: 11/10/82
Time: 324:46 GMT

R/V ACANIA CRUISE ODEX3 STATION 146

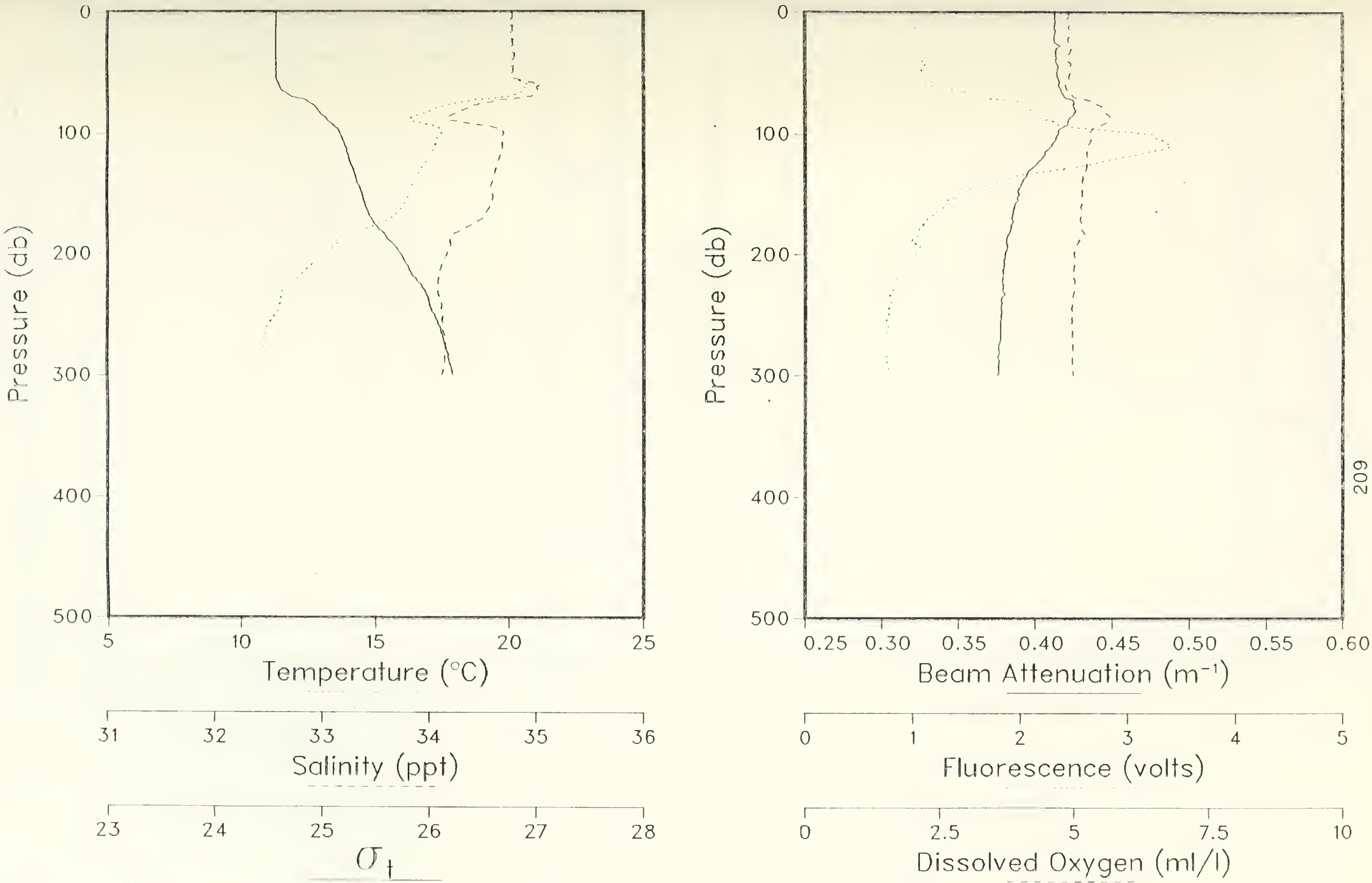




Latitude: 32.533°
Longitude: 142.917°

Date: 11/10/82
Time: 505:55 GMT

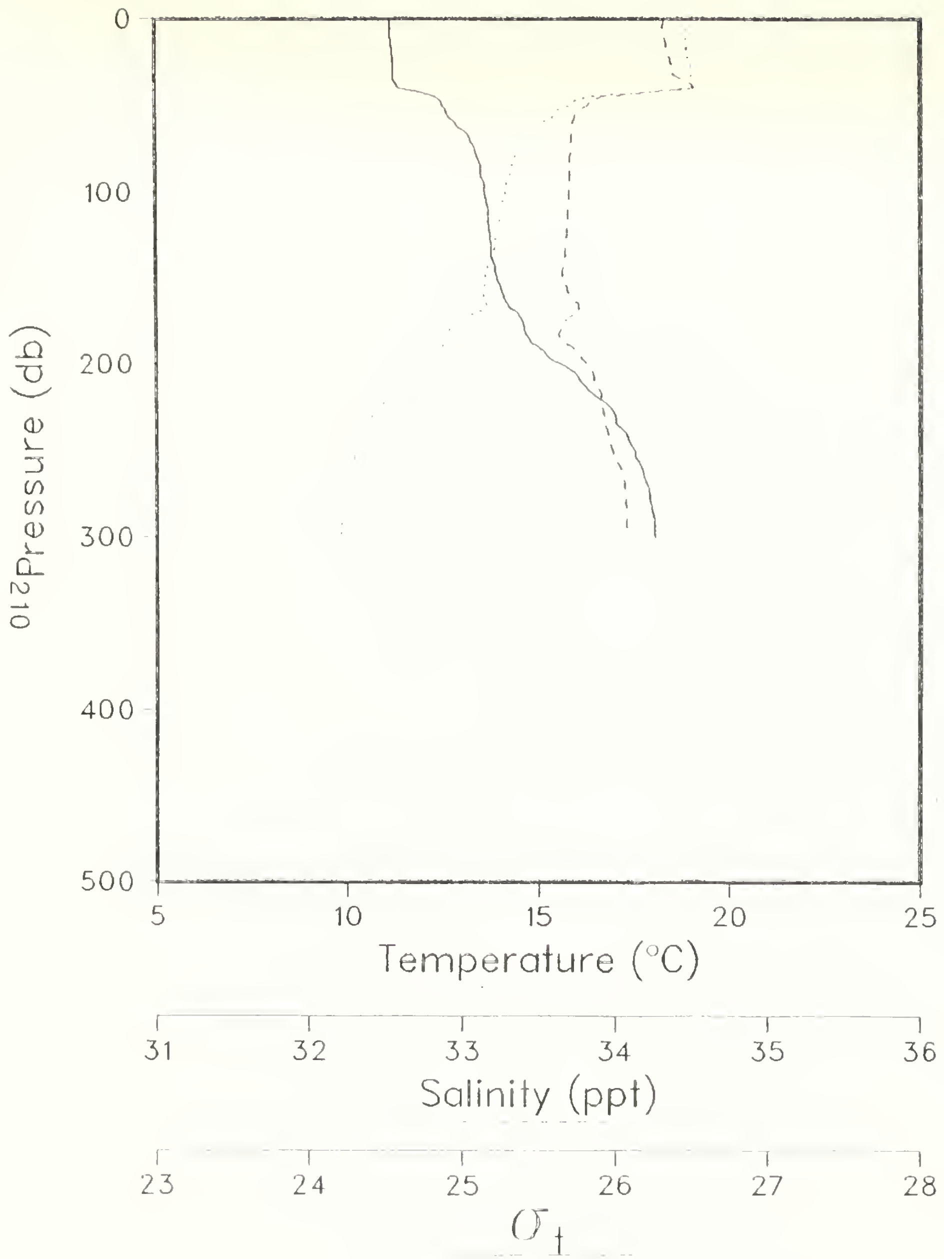
R/V ACANIA CRUISE ODEX3 STATION 147

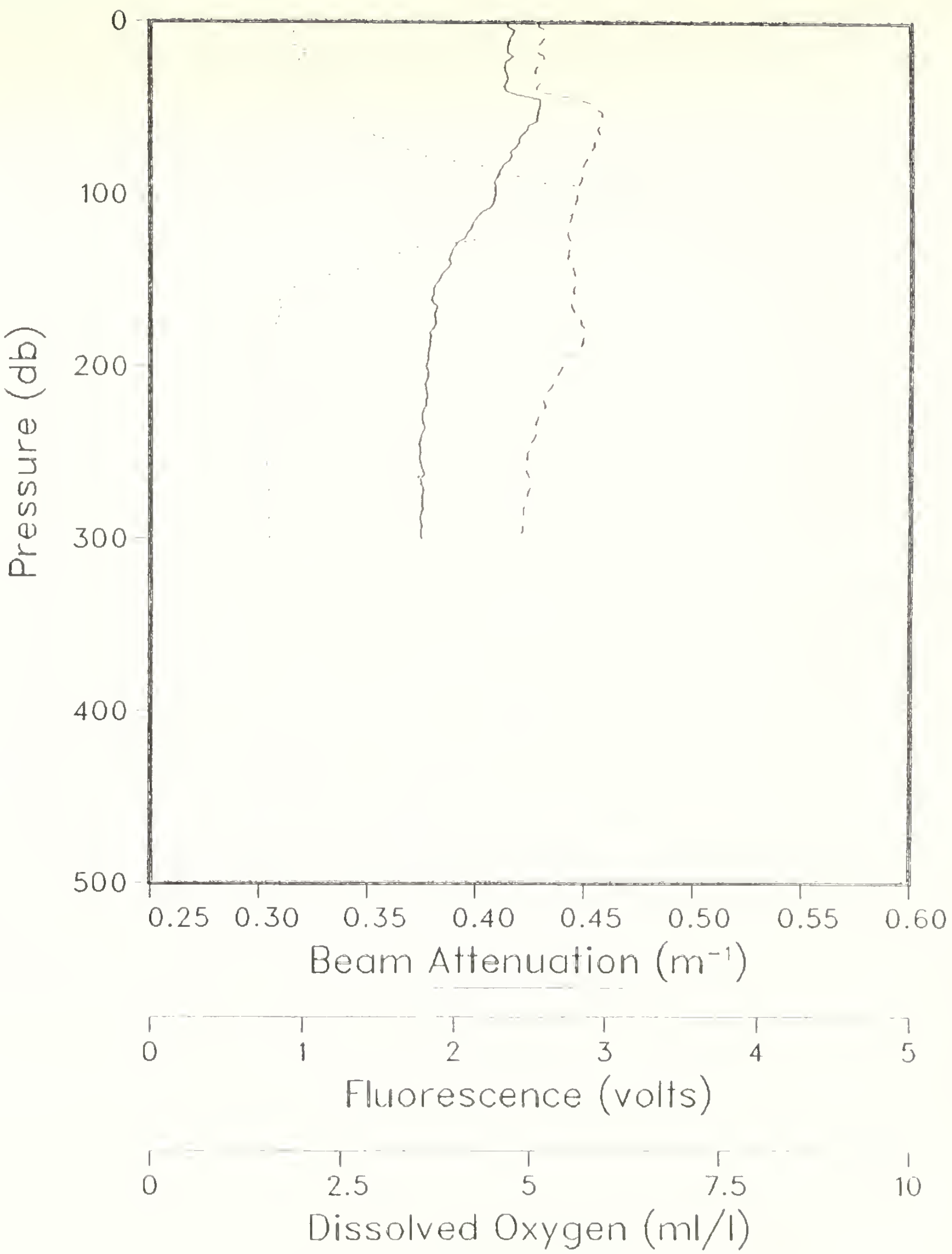


Latitude: 32.887°
Longitude: 142.883°

Date: 11/10/82
Time: 922:07 GMT

R/V ACANIA CRUISE ODEX3 STATION 150

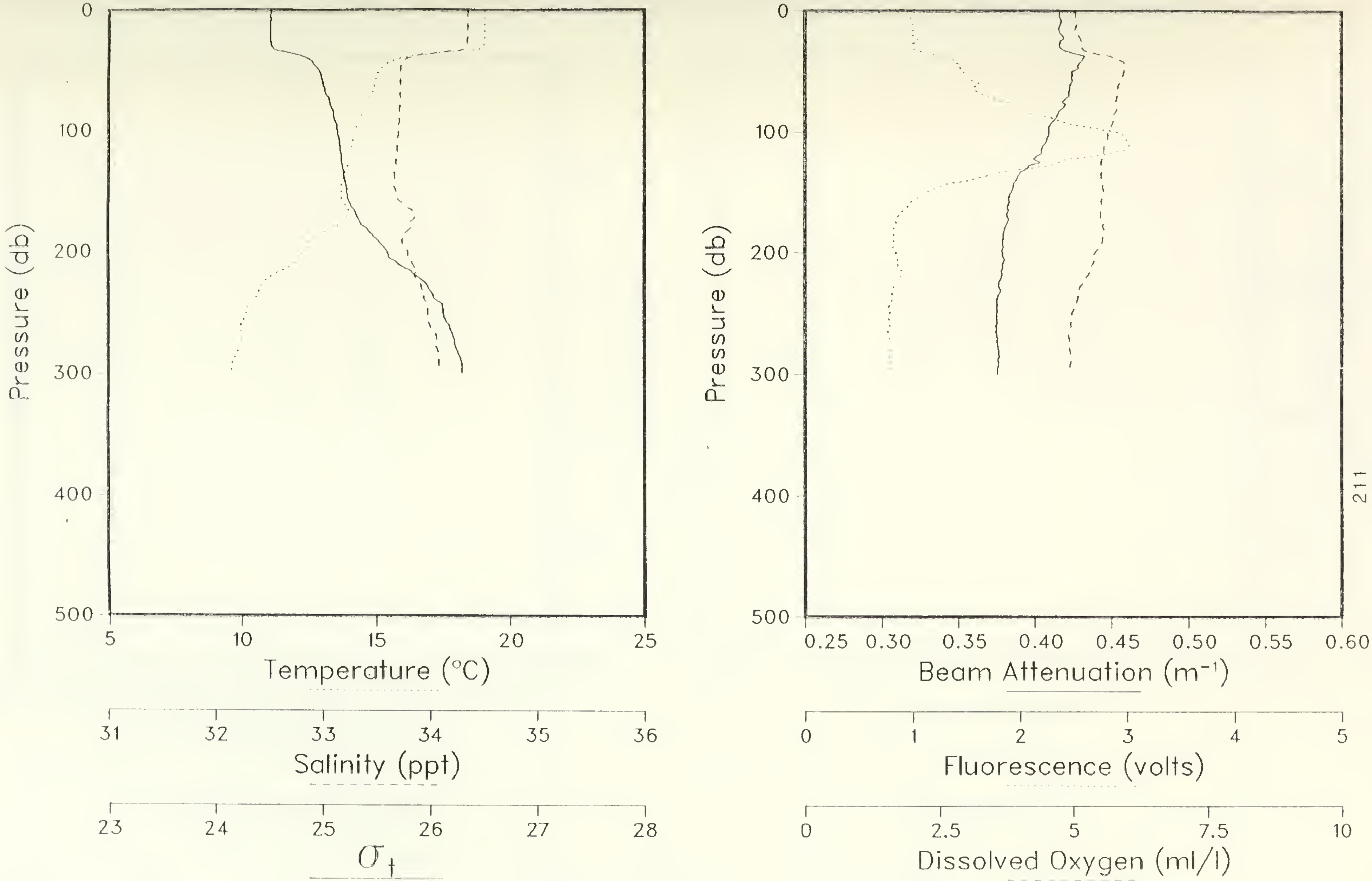




Latitude: 32.883°
Longitude: 142.500°

Date: 11/10/82
Time: 1225:35 GMT

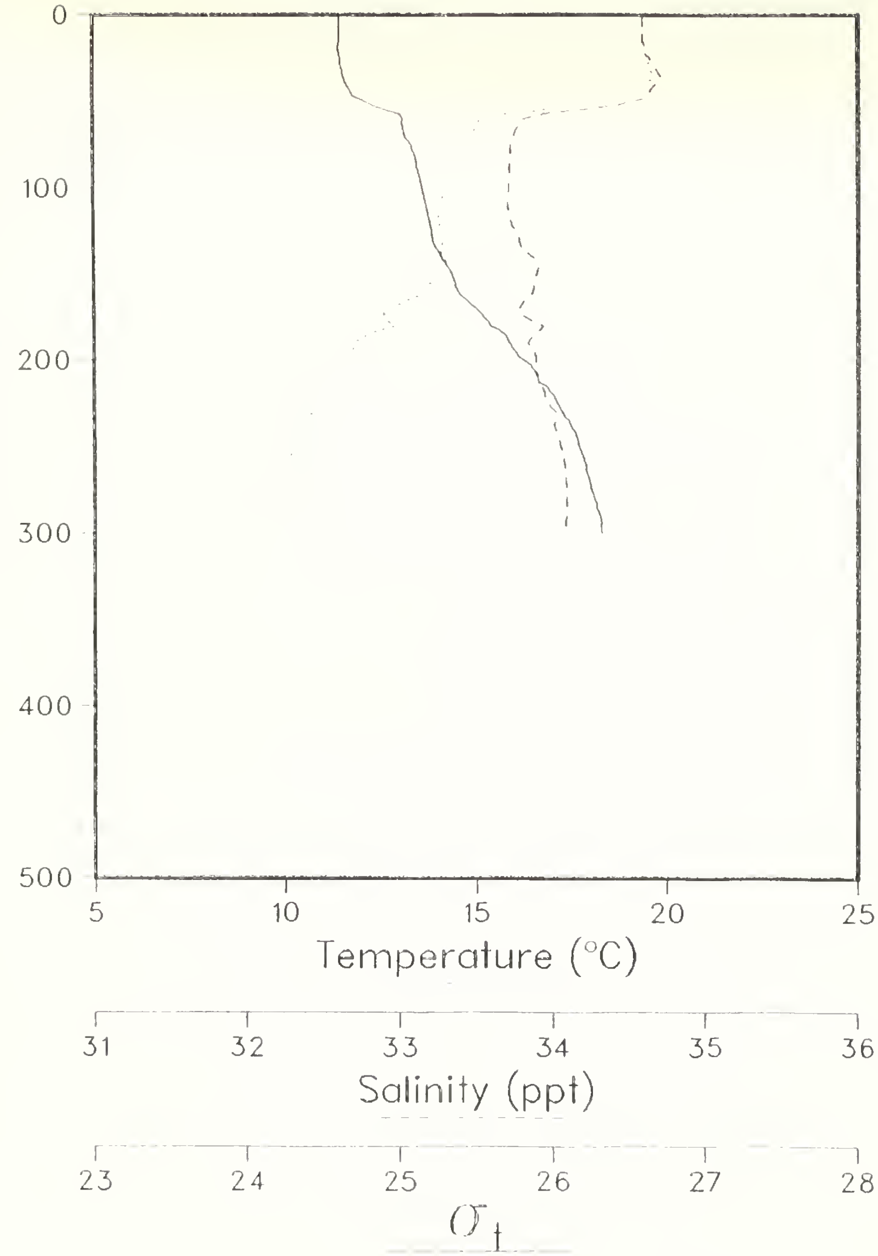
R/V ACANIA CRUISE ODEX3 STATION 151

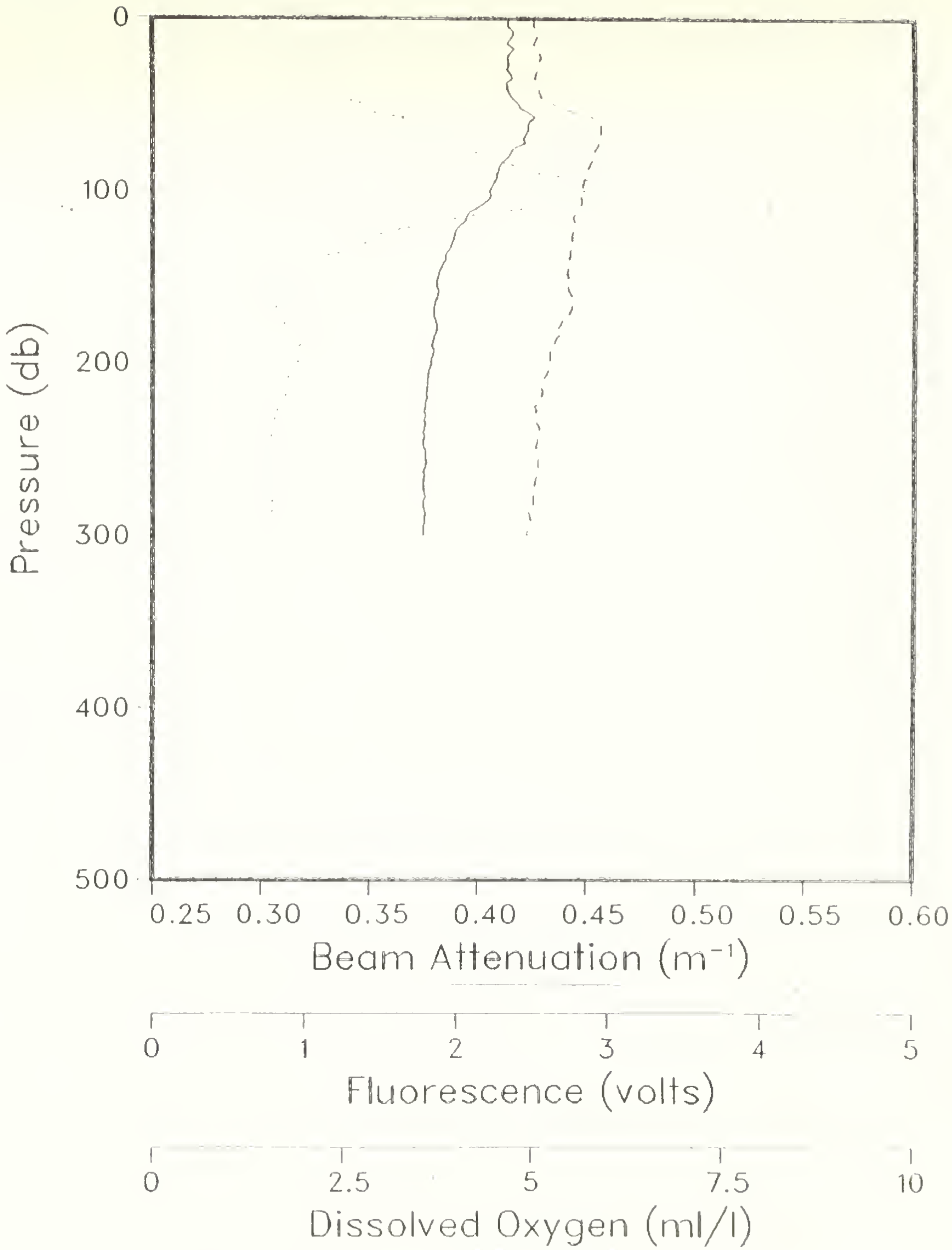


Latitude: 32.889°
Longitude: 142.312°

Date: 11/10/82
Time: 1411:01 GMT

R/V ACANIA CRUISE ODEX3 STATION 152

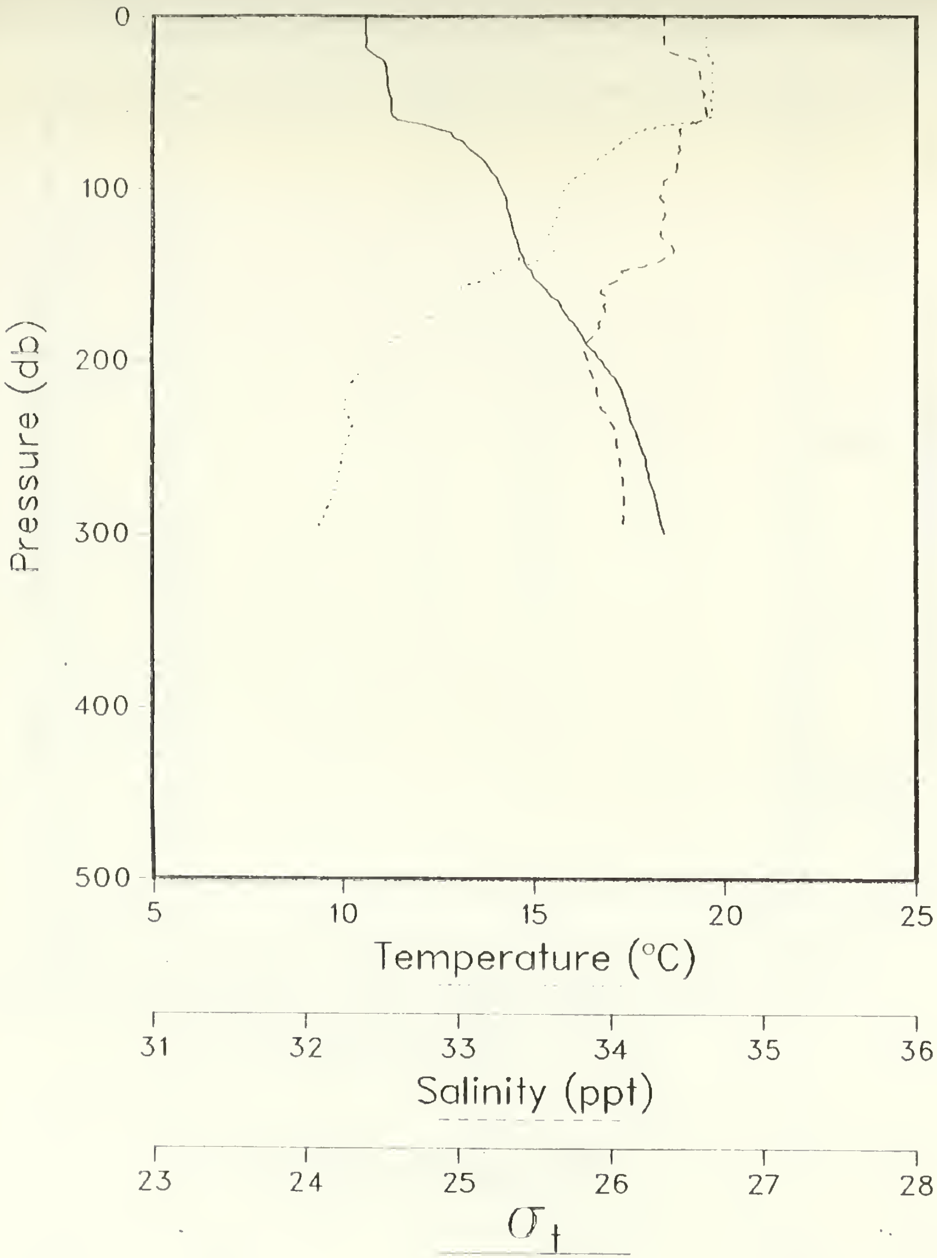


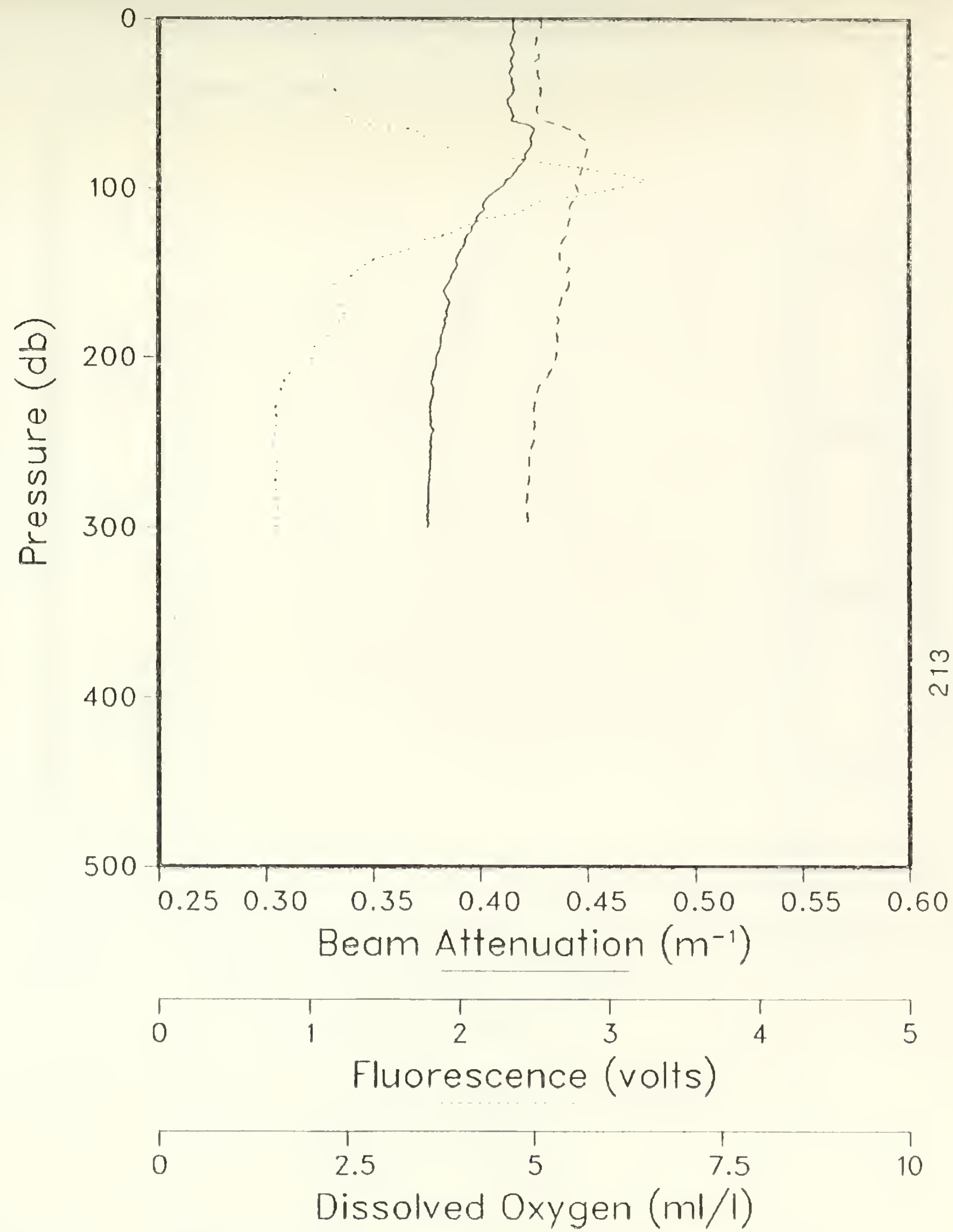


Latitude: 32.868°
Longitude: 142.129°

Date: 11/10/82
Time: 1552:00 GMT

R/V ACANIA CRUISE ODEX3 STATION 153

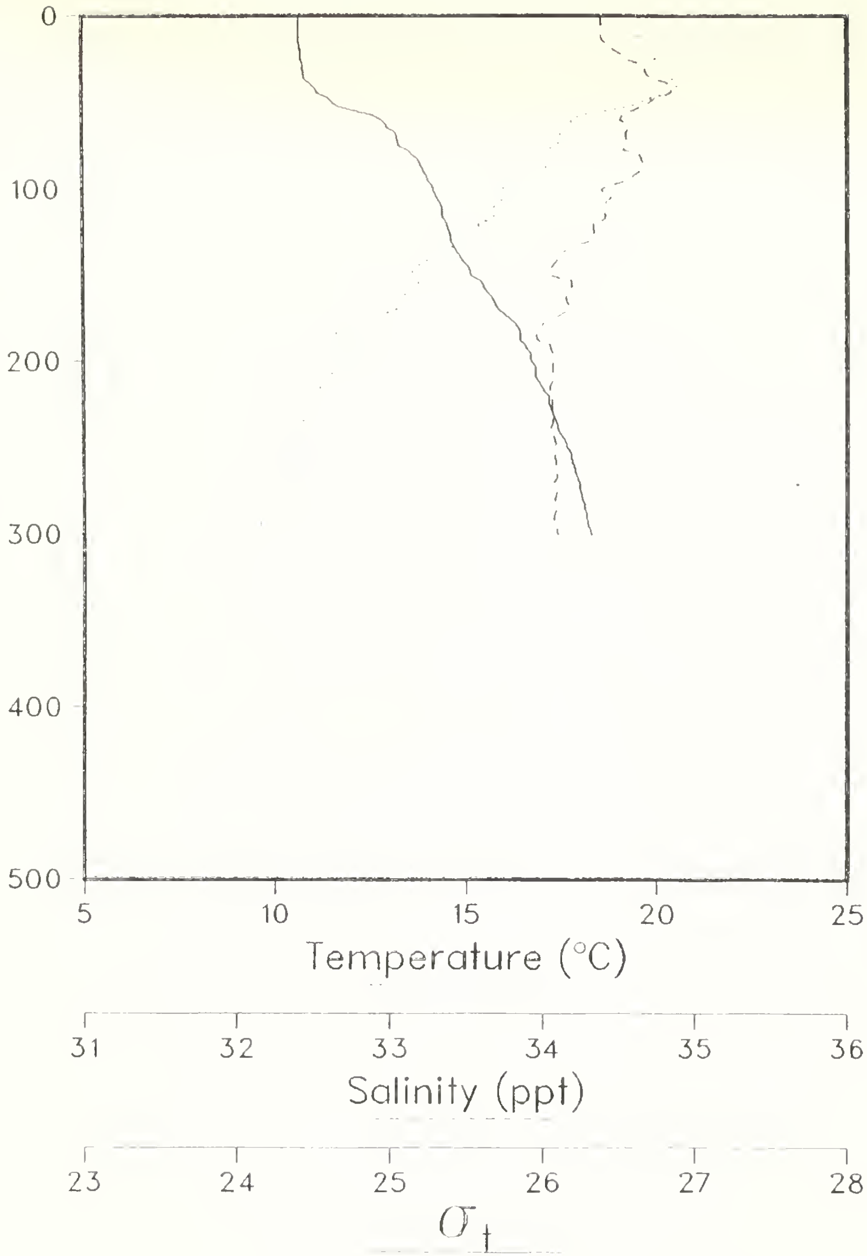


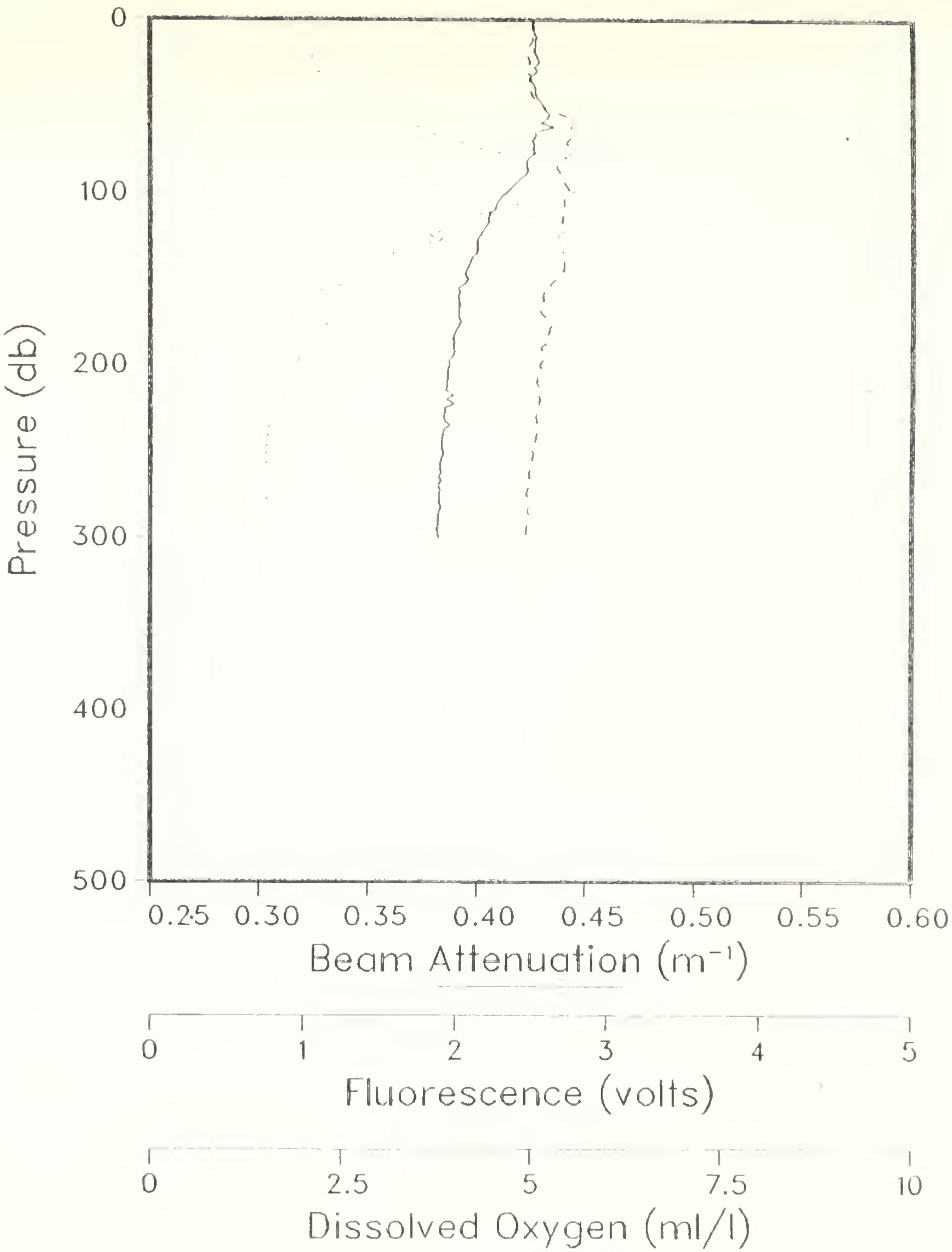


Latitude: 32.862°
Longitude: 141.949°

Date: 11/10/82
Time: 1731:41 GMT

R/V ACANIA CRUISE ODEX3 STATION 154

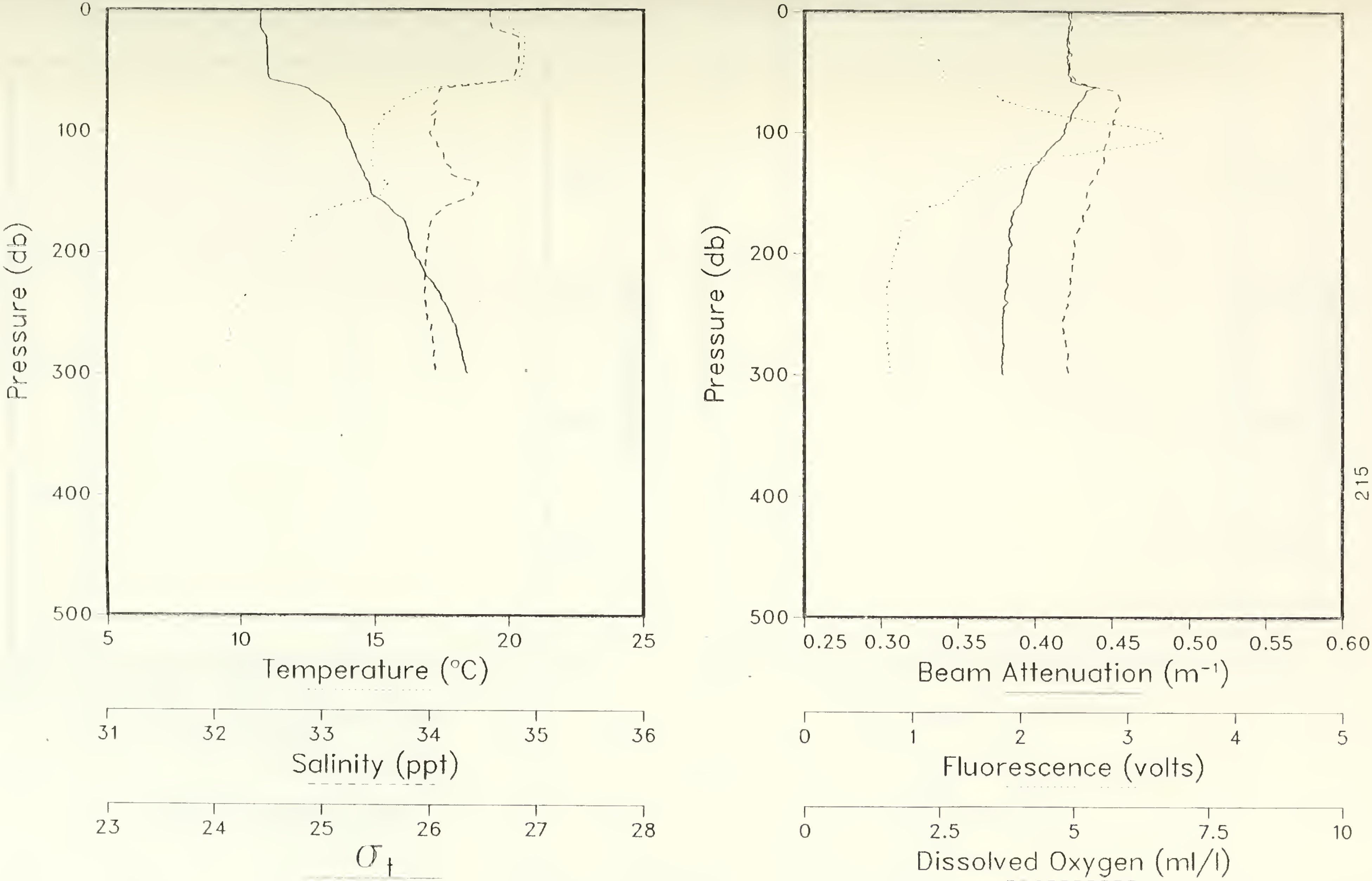




Latitude: 32.878°
Longitude: 141.768°

Date: 11/10/82
Time: 2005:23 GMT

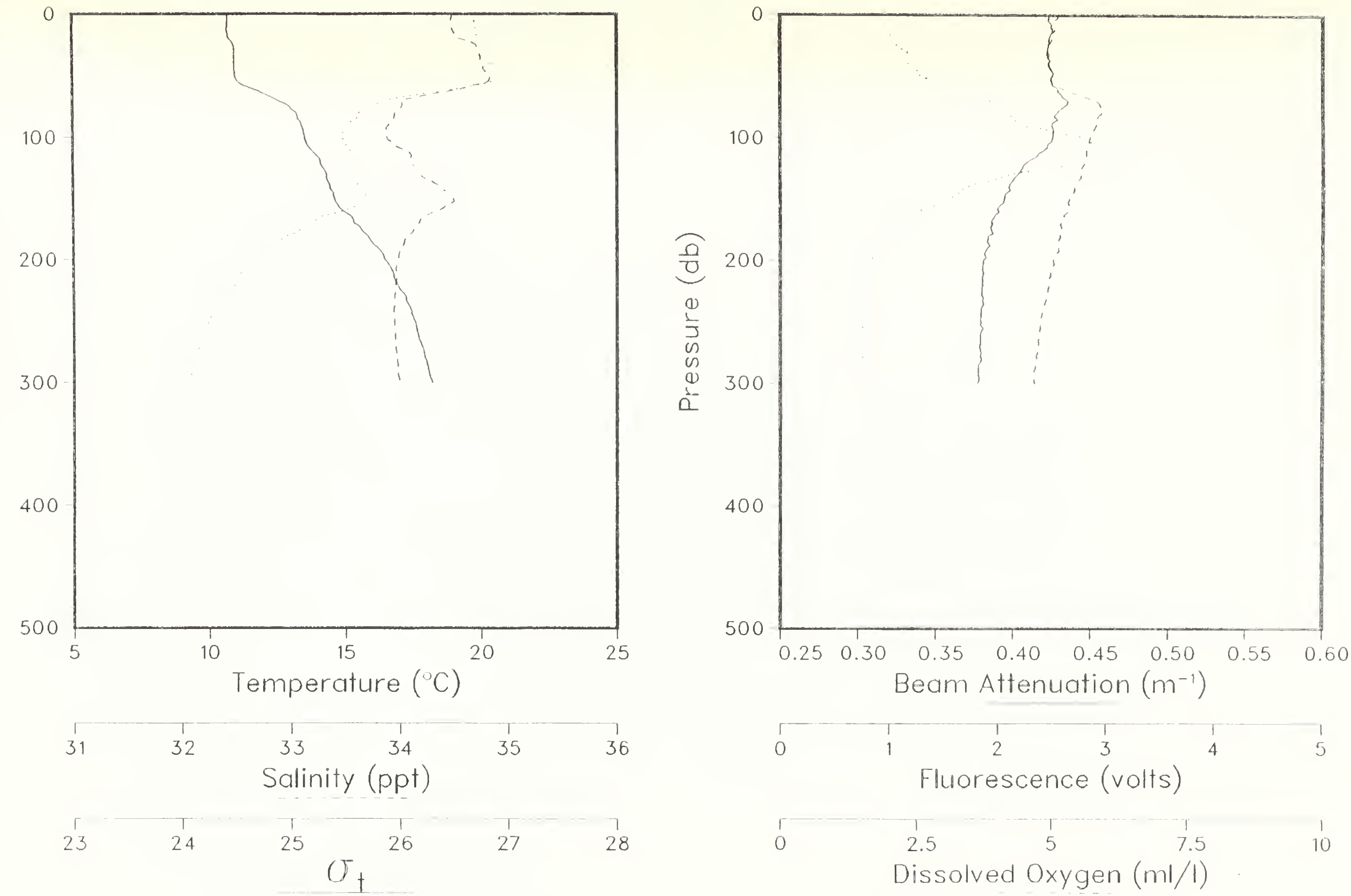
R/V ACANIA CRUISE ODEX3 STATION 155



Latitude: 32.892°
Longitude: 141.652°

Date: 11/10/82
Time: 2128:29 GMT

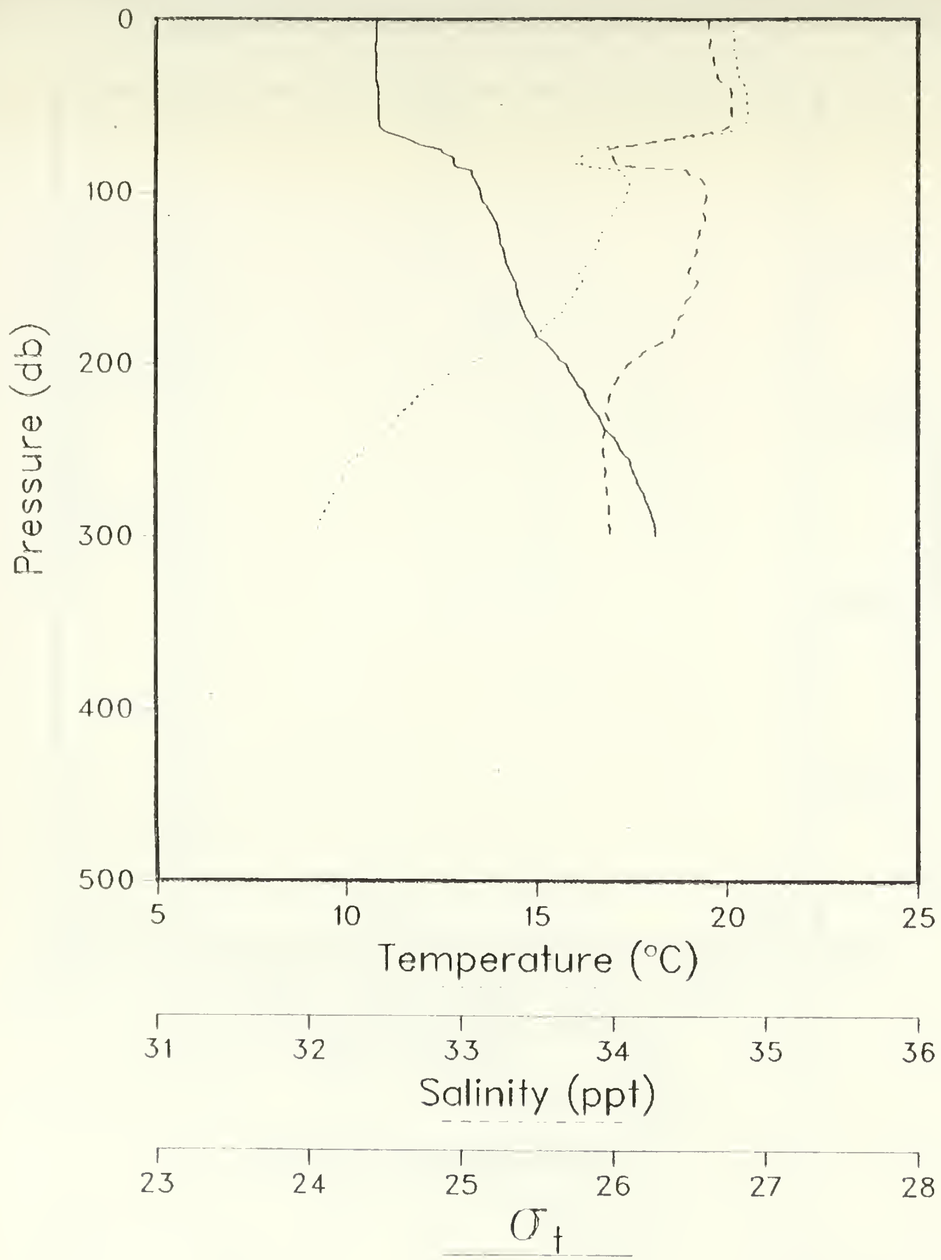
R/V ACANIA CRUISE ODEX3 STATION 156

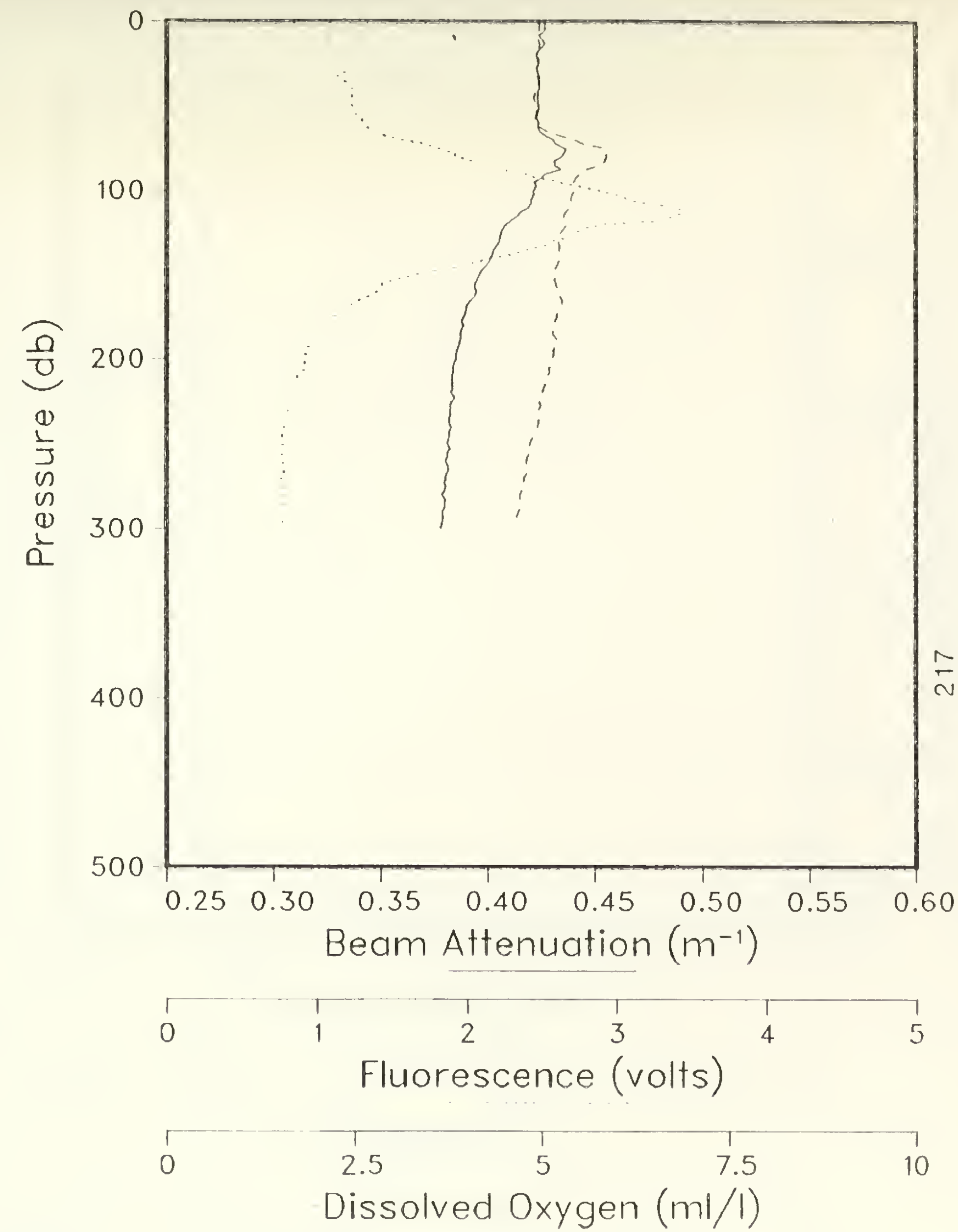


Latitude: 32.917°
Longitude: 141.527°

Date: 11/10/82
Time: 2:40 GMT

R/V ACANIA CRUISE ODEX3 STATION 157

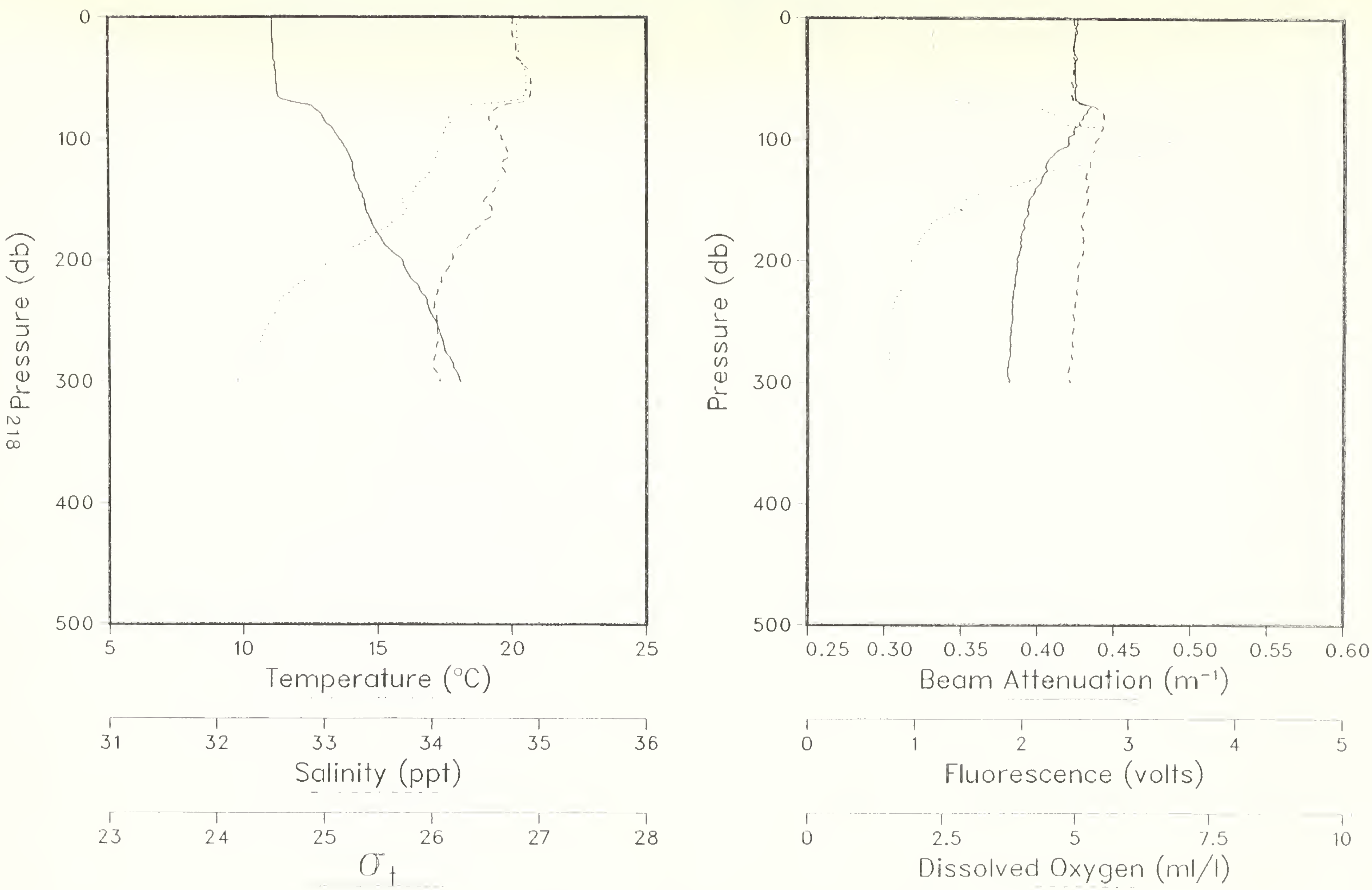




Latitude: 32.883°
Longitude: 141.388°

Date: 11/11/82
Time: 125:06 GMT

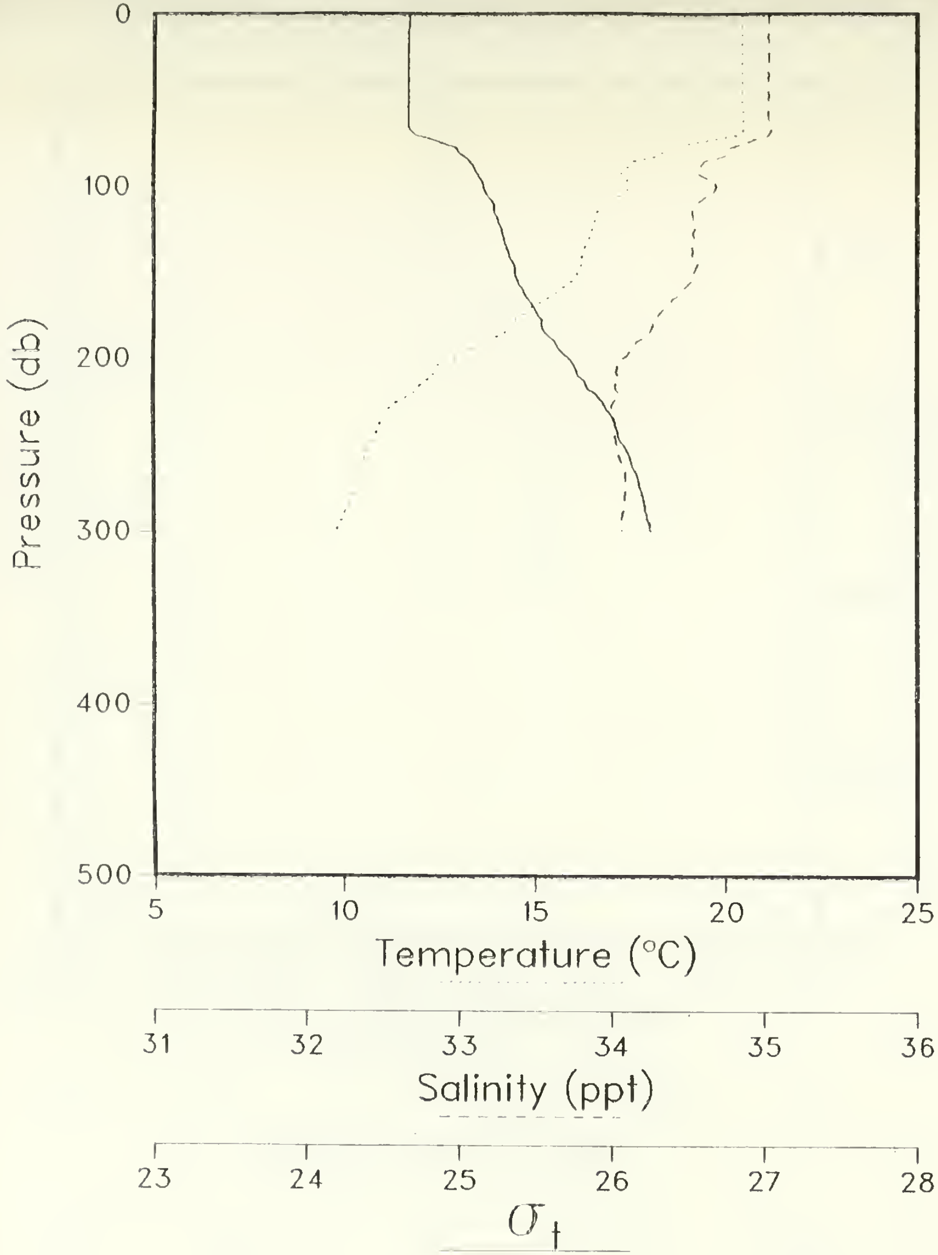
R/V ACANIA CRUISE ODEX3 STATION 158

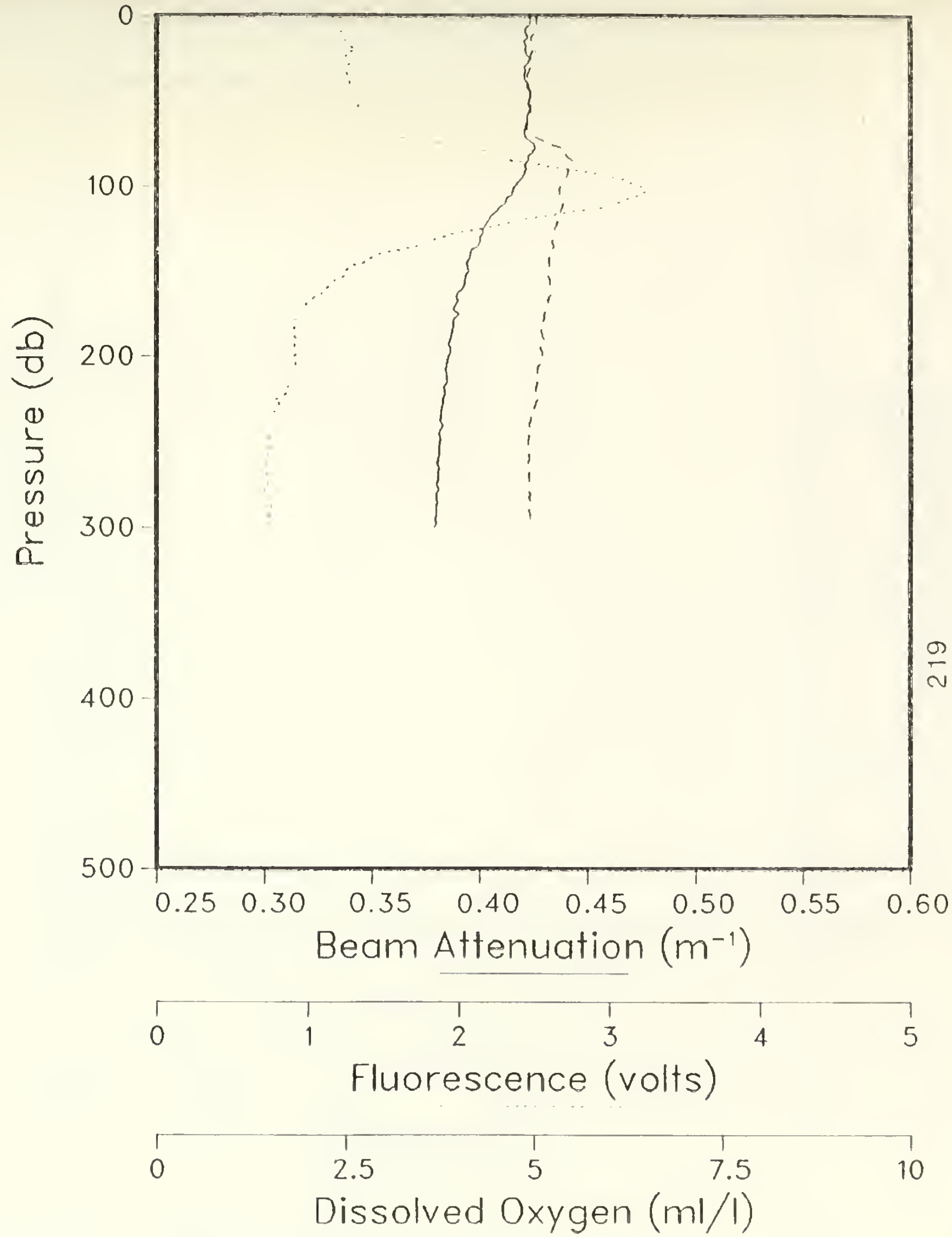


Latitude: 32.867°
Longitude: 141.238°

Date: 11/11/82
Time: 259:32 GMT

R/V ACANIA CRUISE ODEX3 STATION 159

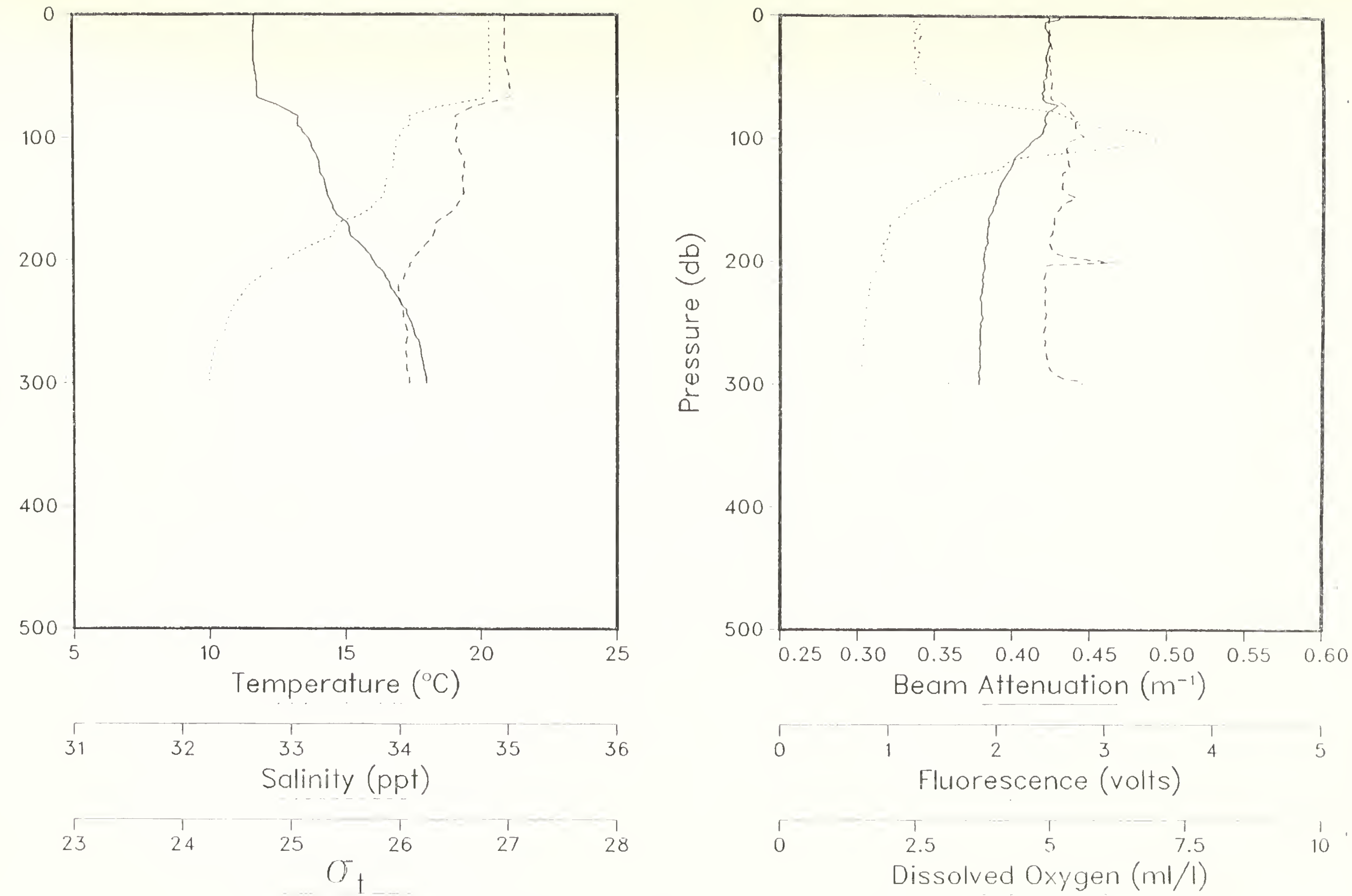




Latitude: 32.866°
Longitude: 140.818°

Date: 11/11/82
Time: 611:54 GMT

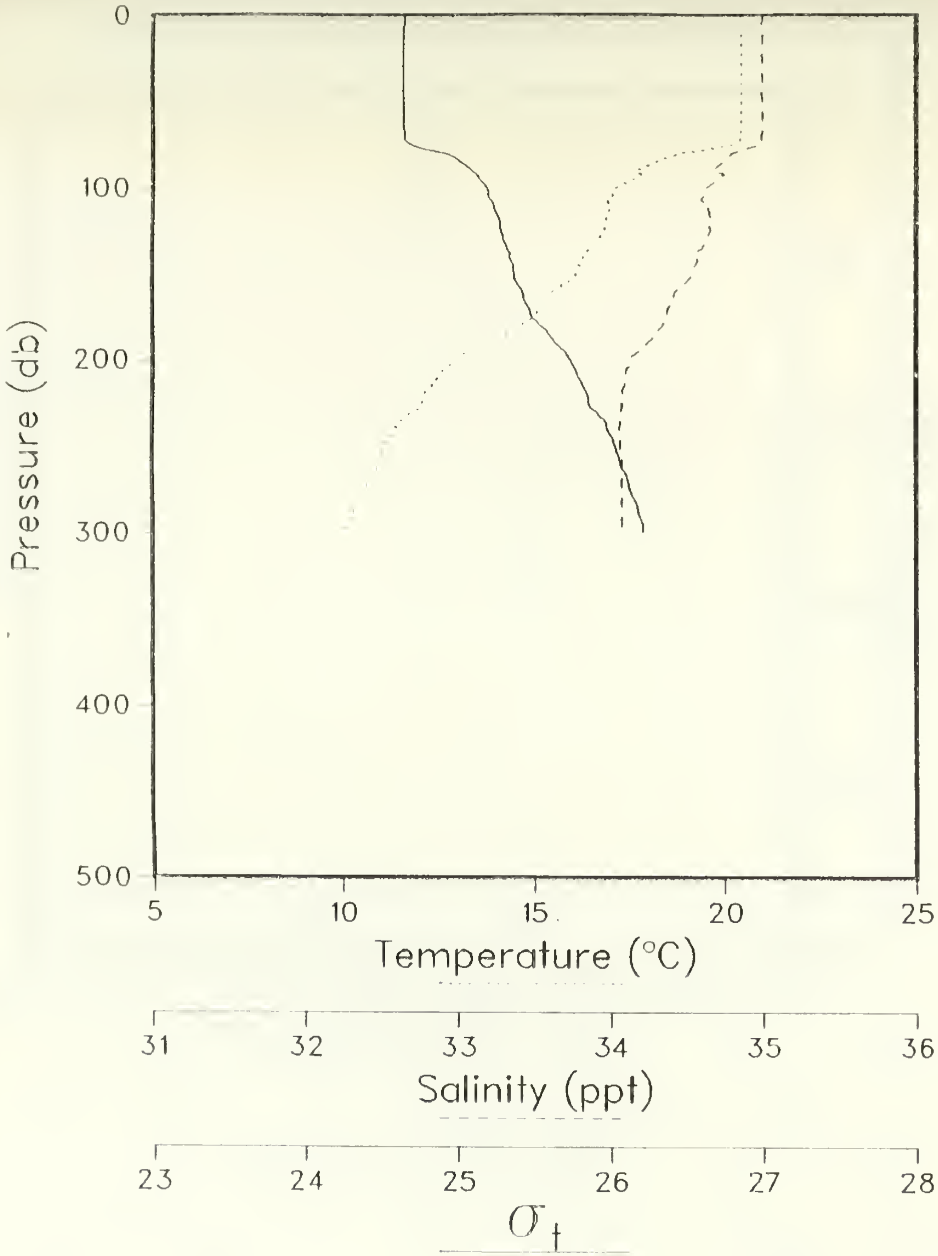
R/V ACANIA CRUISE ODEX3 STATION 160

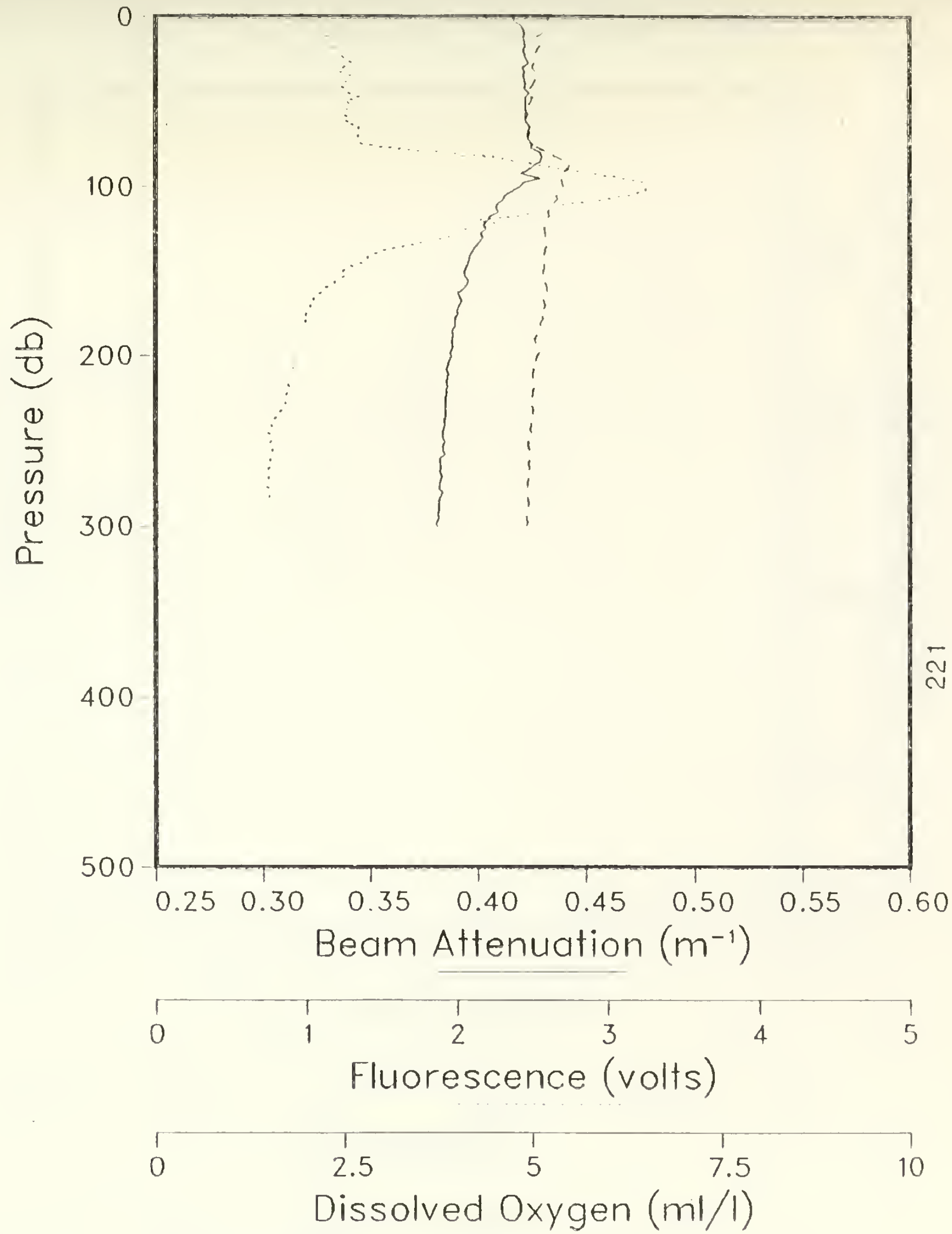


Latitude: 32.982°
Longitude: 140.852°

Date: 11/11/82
Time: 816:45 GMT

R/V ACANIA CRUISE ODEX3 STATION 161

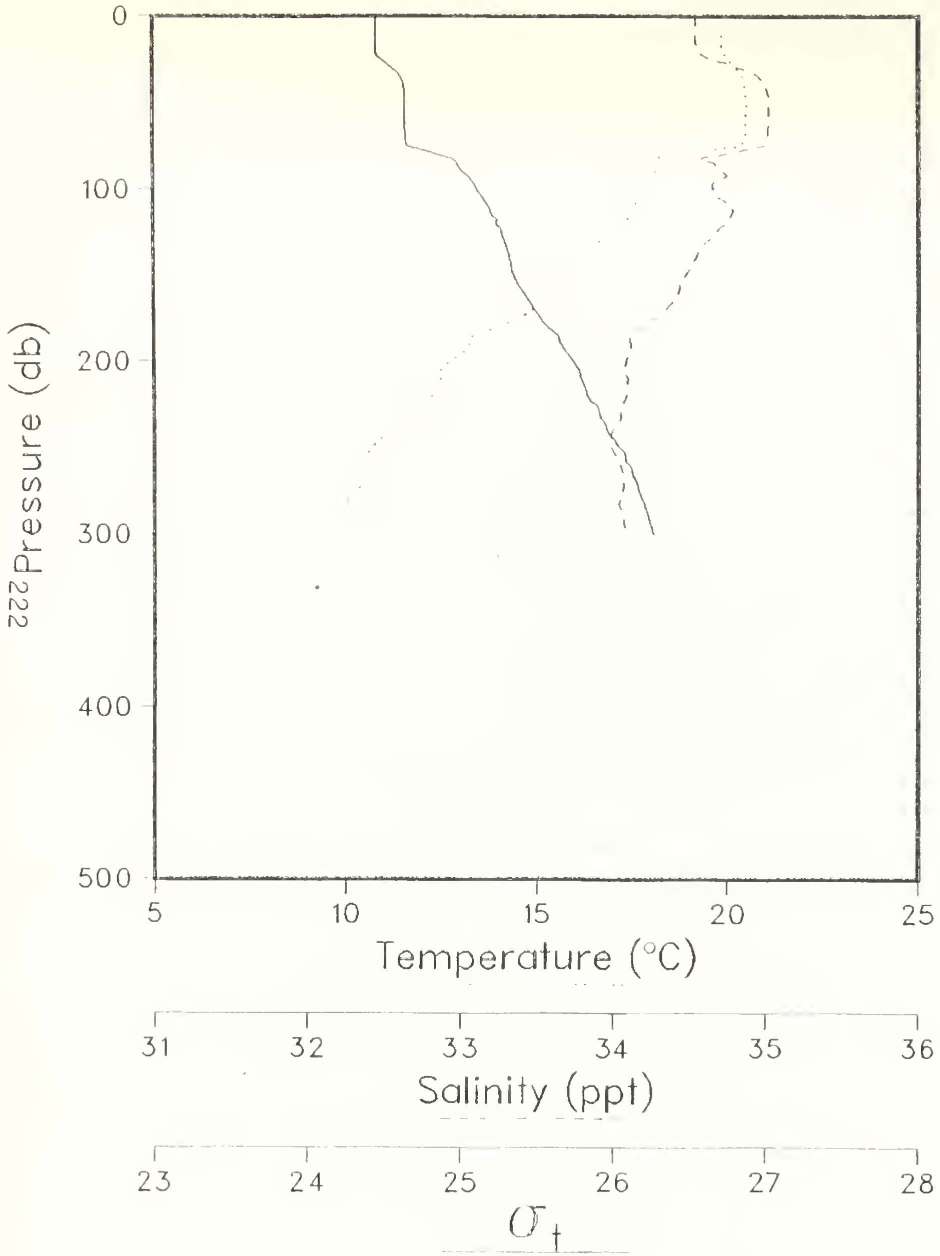


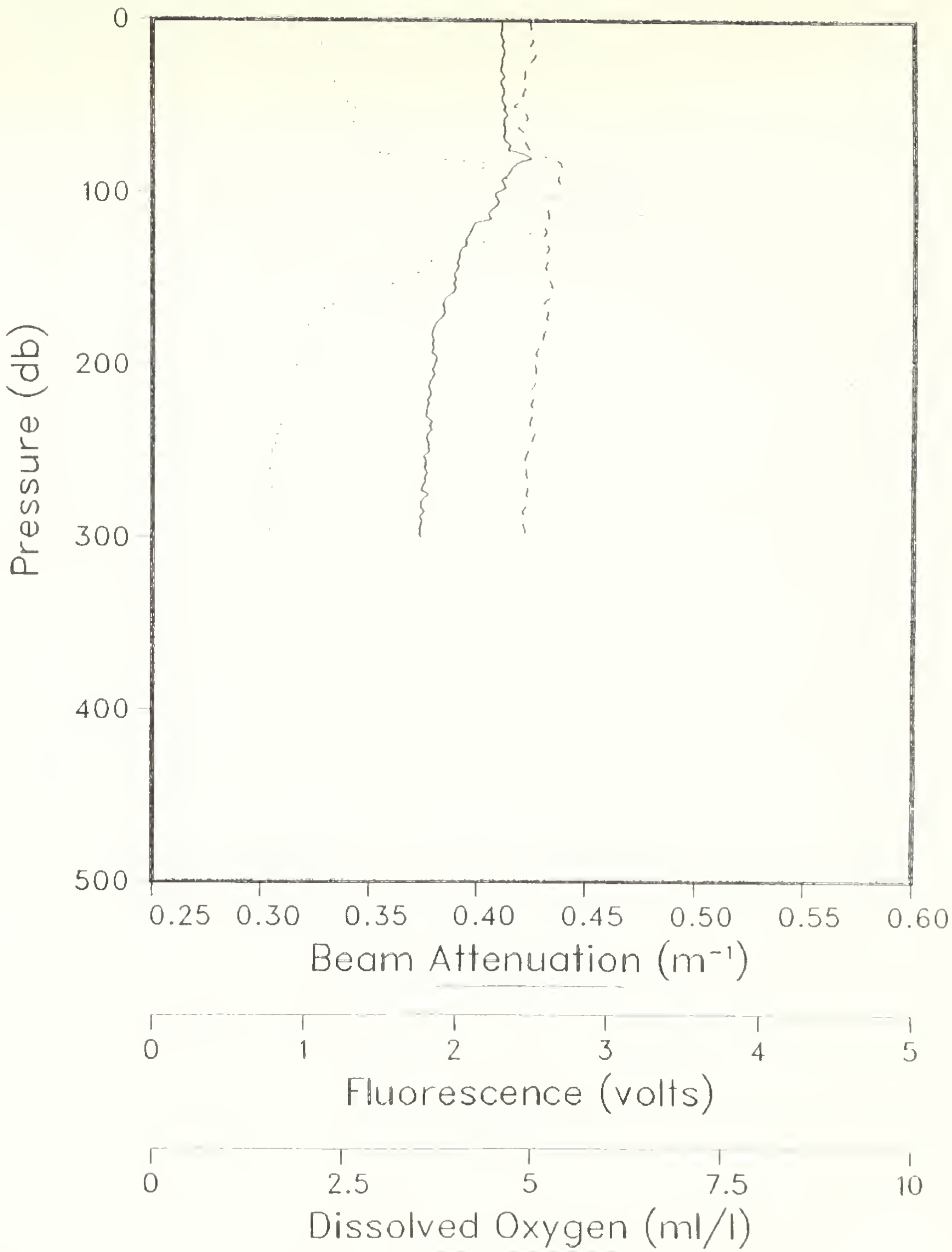


Latitude: 33.117°
Longitude: 140.833°

Date: 11/11/82
Time: 956:36 GMT

R/V ACANIA CRUISE ODEX3 STATION 162

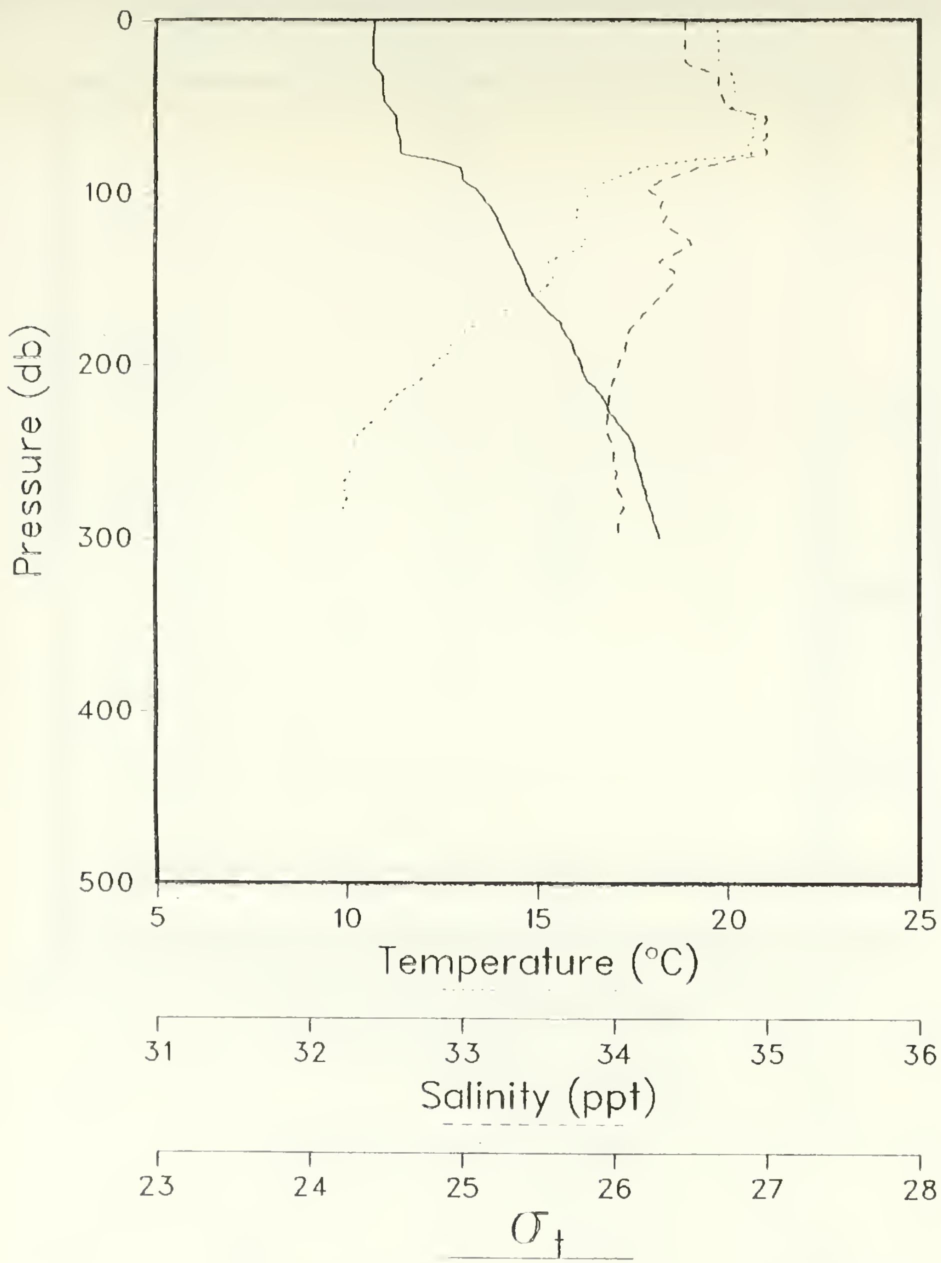


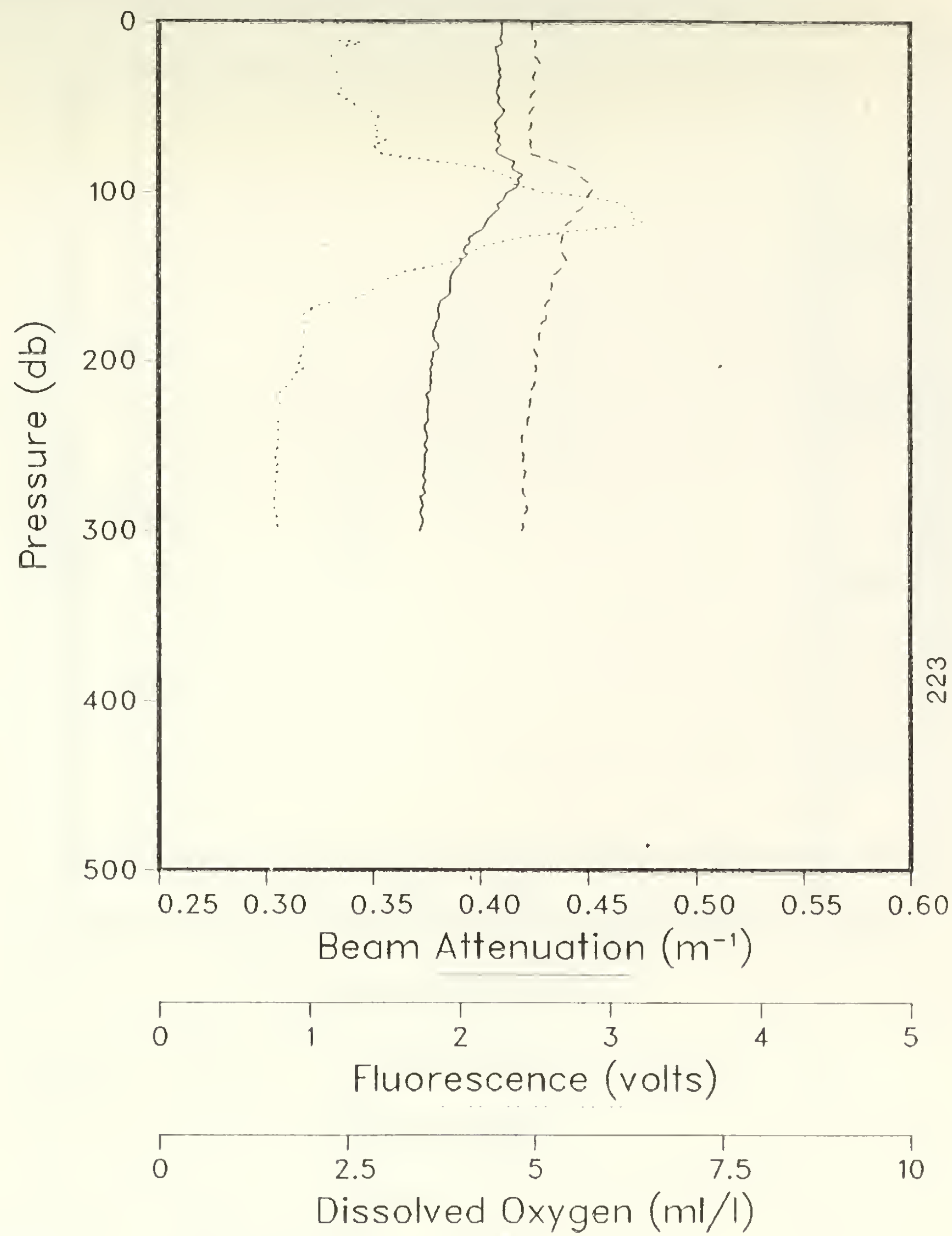


Latitude: 33.265°
Longitude: 140.803°

Date: 11/11/82
Time: 1258:58 GMT

R/V ACANIA CRUISE ODEX3 STATION 163

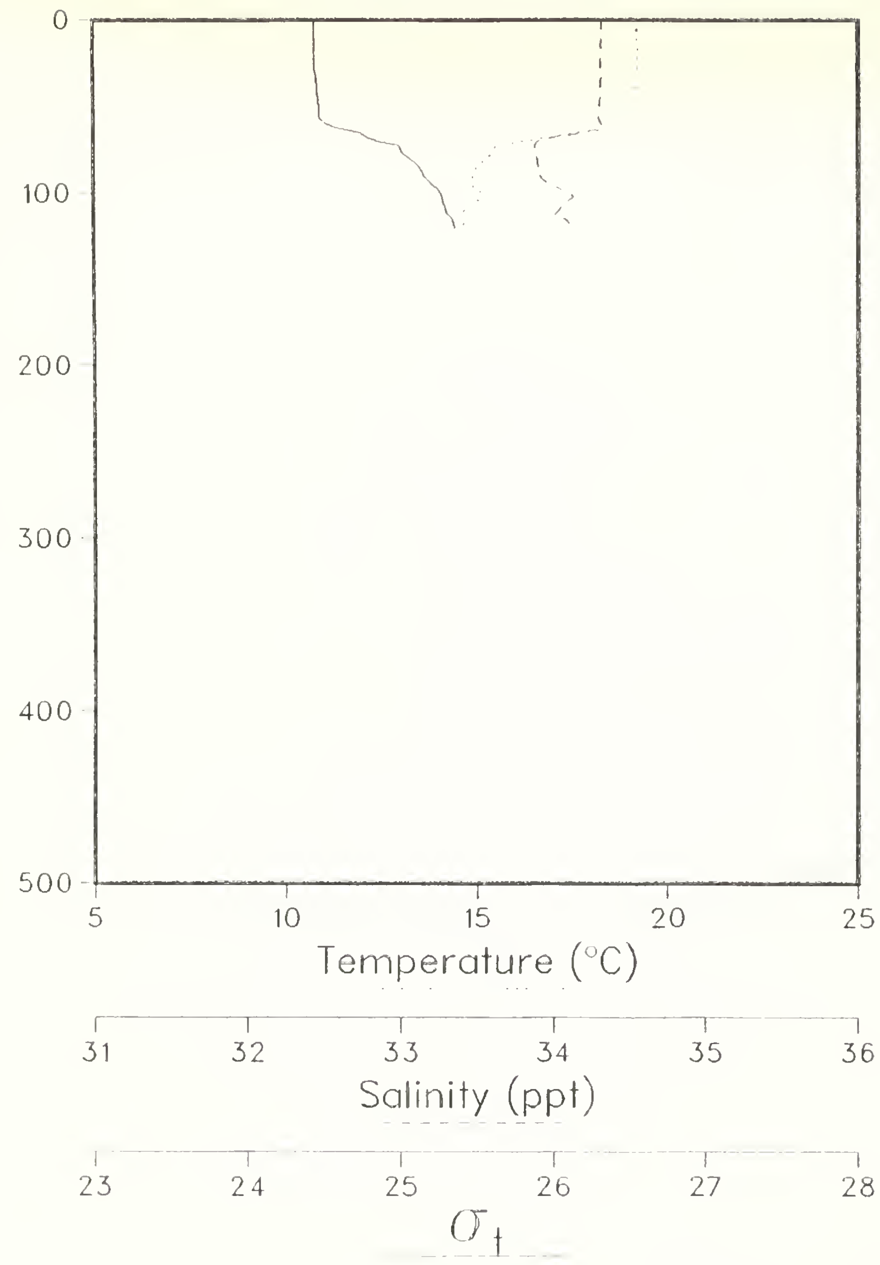


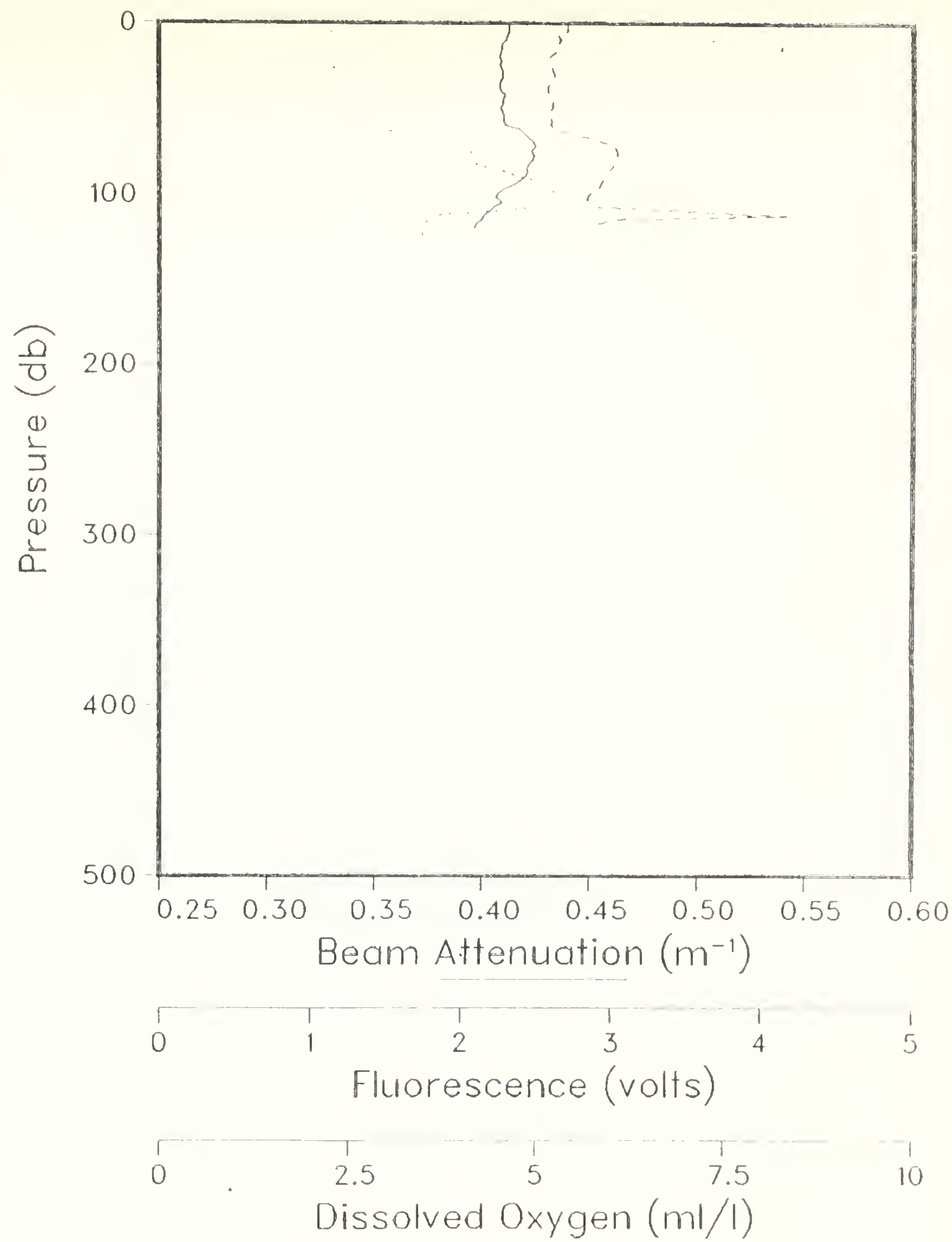


Latitude: 33.346°
Longitude: 140.762°

Date: 11/11/82
Time: 1418:59 GMT

R/V ACANIA CRUISE ODEX3 STATION 164

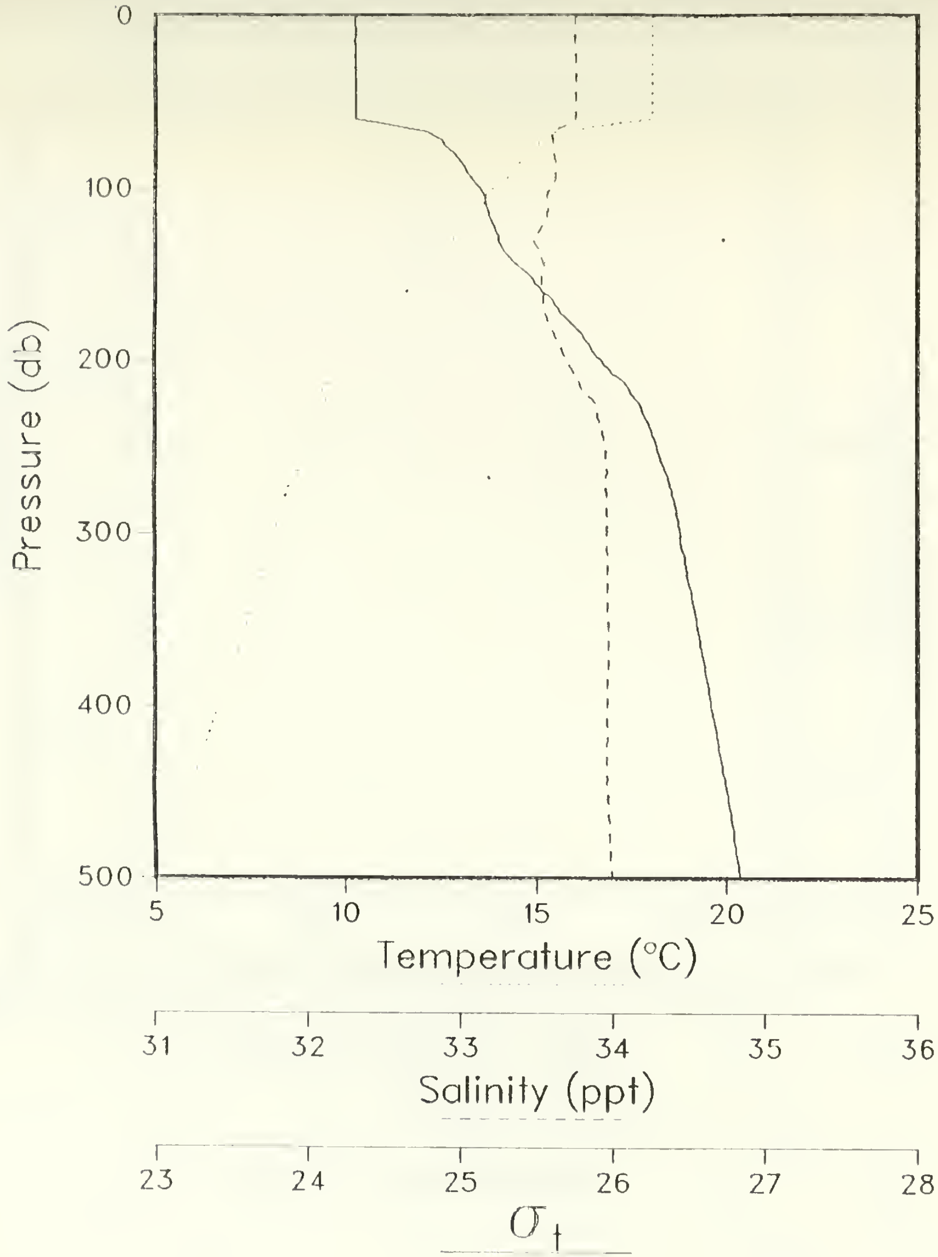


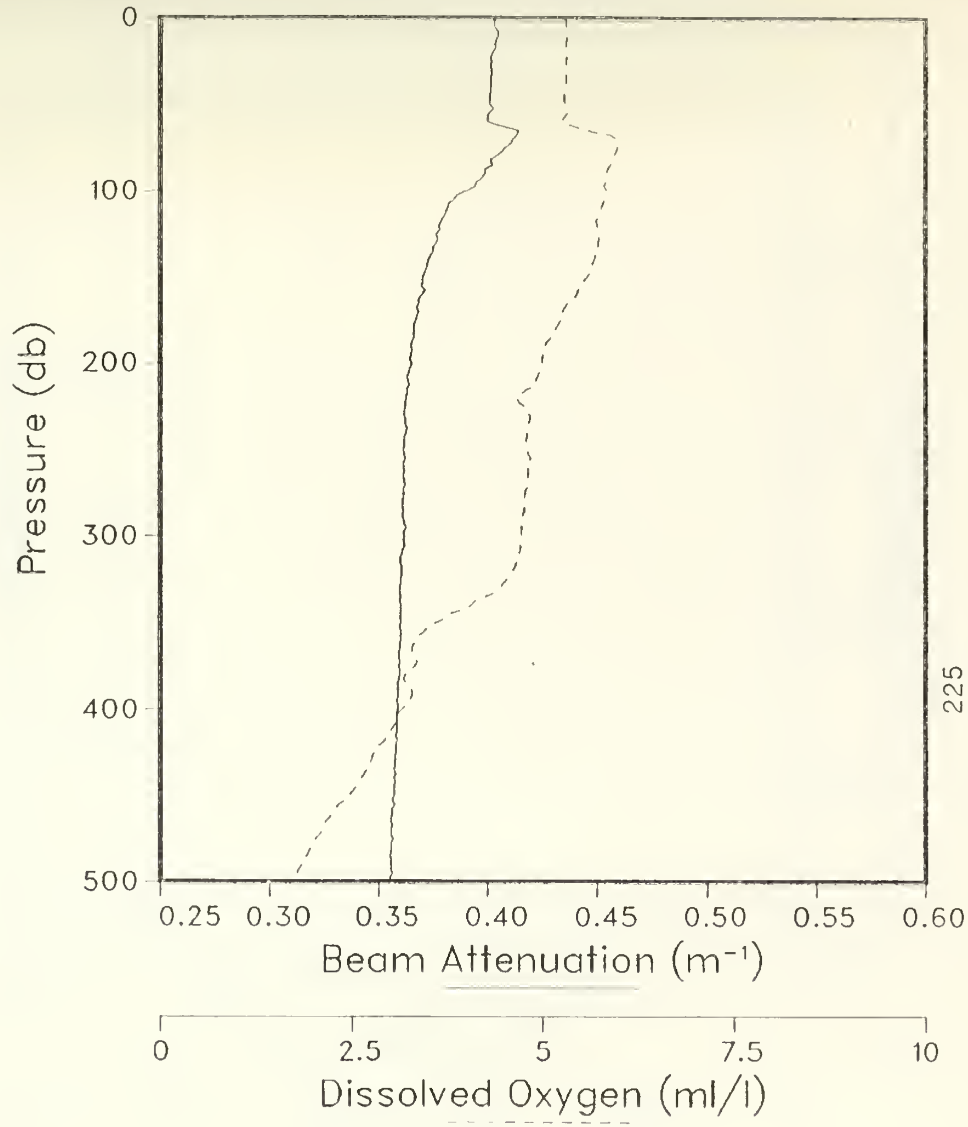


Latitude: 33.467°
Longitude: 140.833°

Date: 11/11/82
Time: 1607:57 GMT

R/V ACANIA CRUISE ODEX3 STATION 165

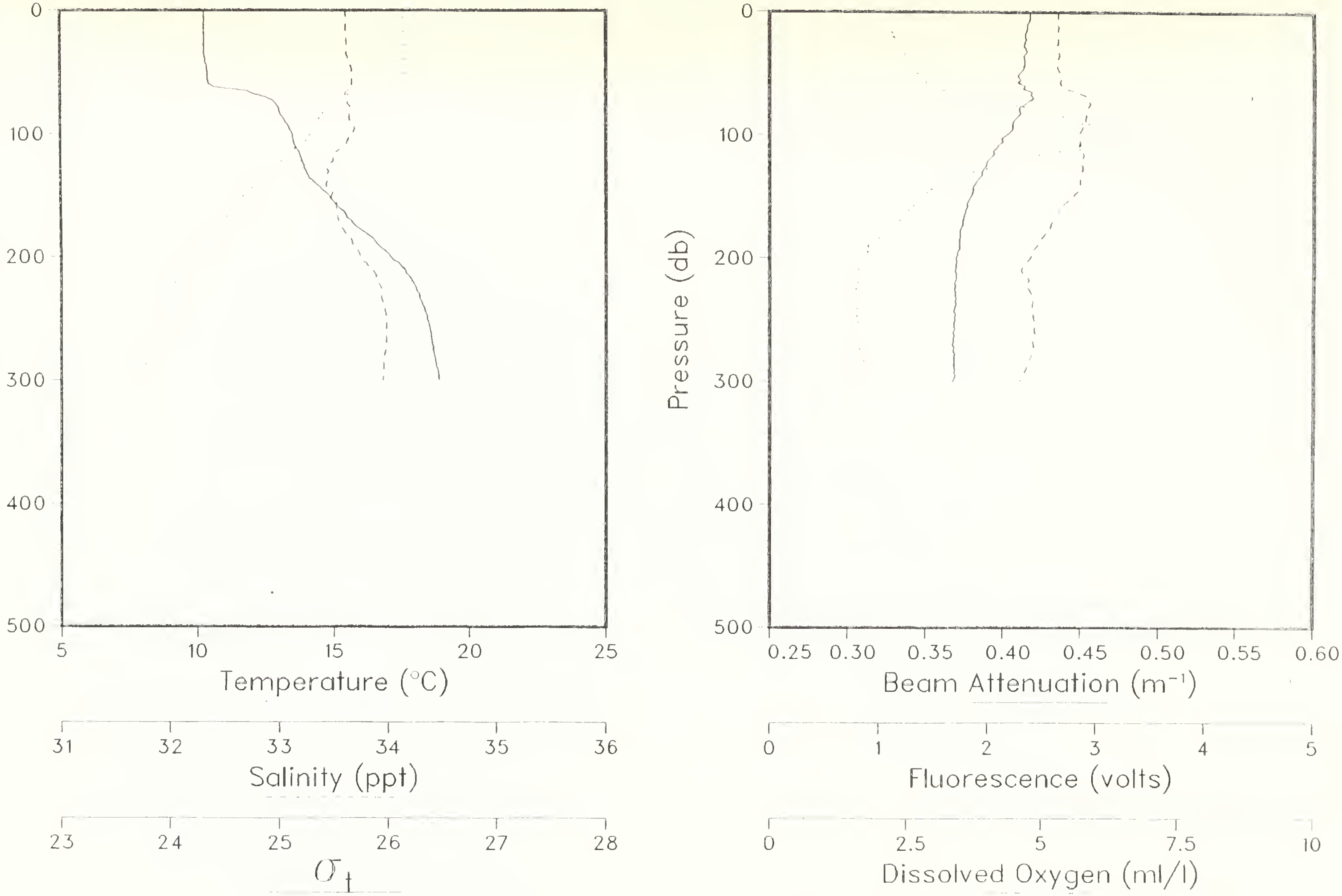




Latitude: 34.235°
Longitude: 133.866°

Date: 11/13/82
Time: 1810:40 GMT

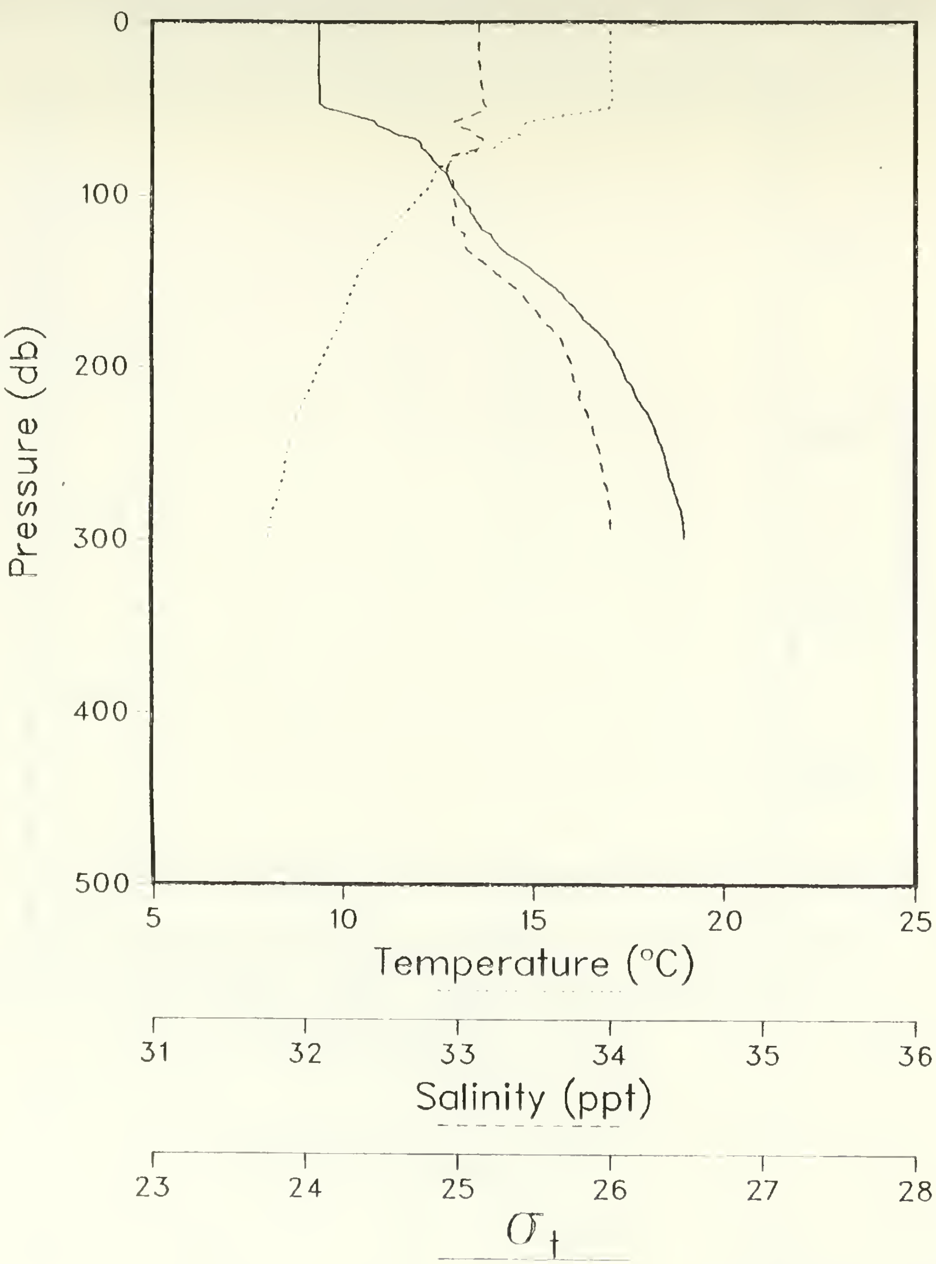
R/V ACANIA CRUISE ODEX3 STATION 168

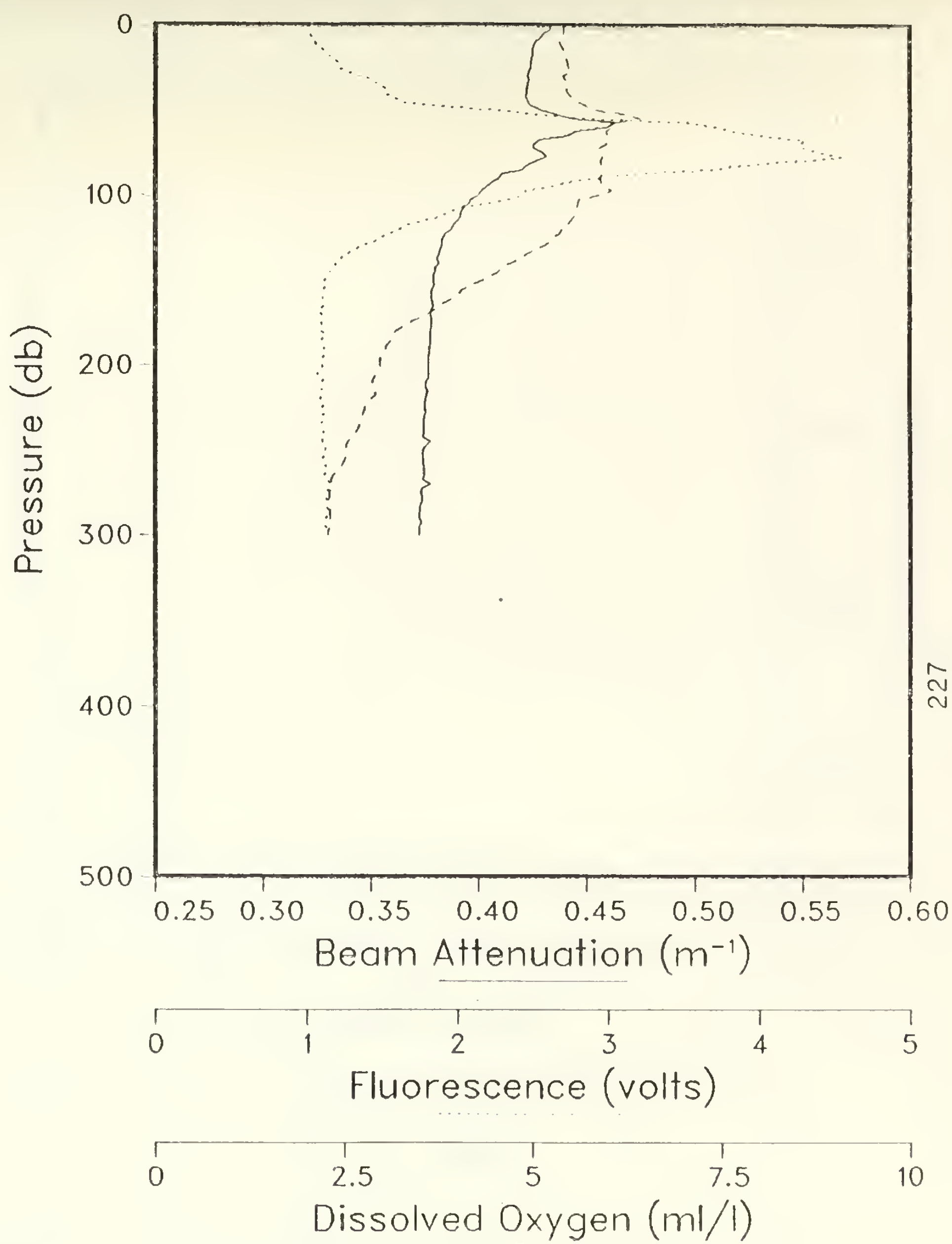


Latitude: 34.525°
Longitude: 130.605°

Date: 11/14/82
Time: 1904:10 GMT

R/V ACANIA CRUISE ODEX3 STATION 169

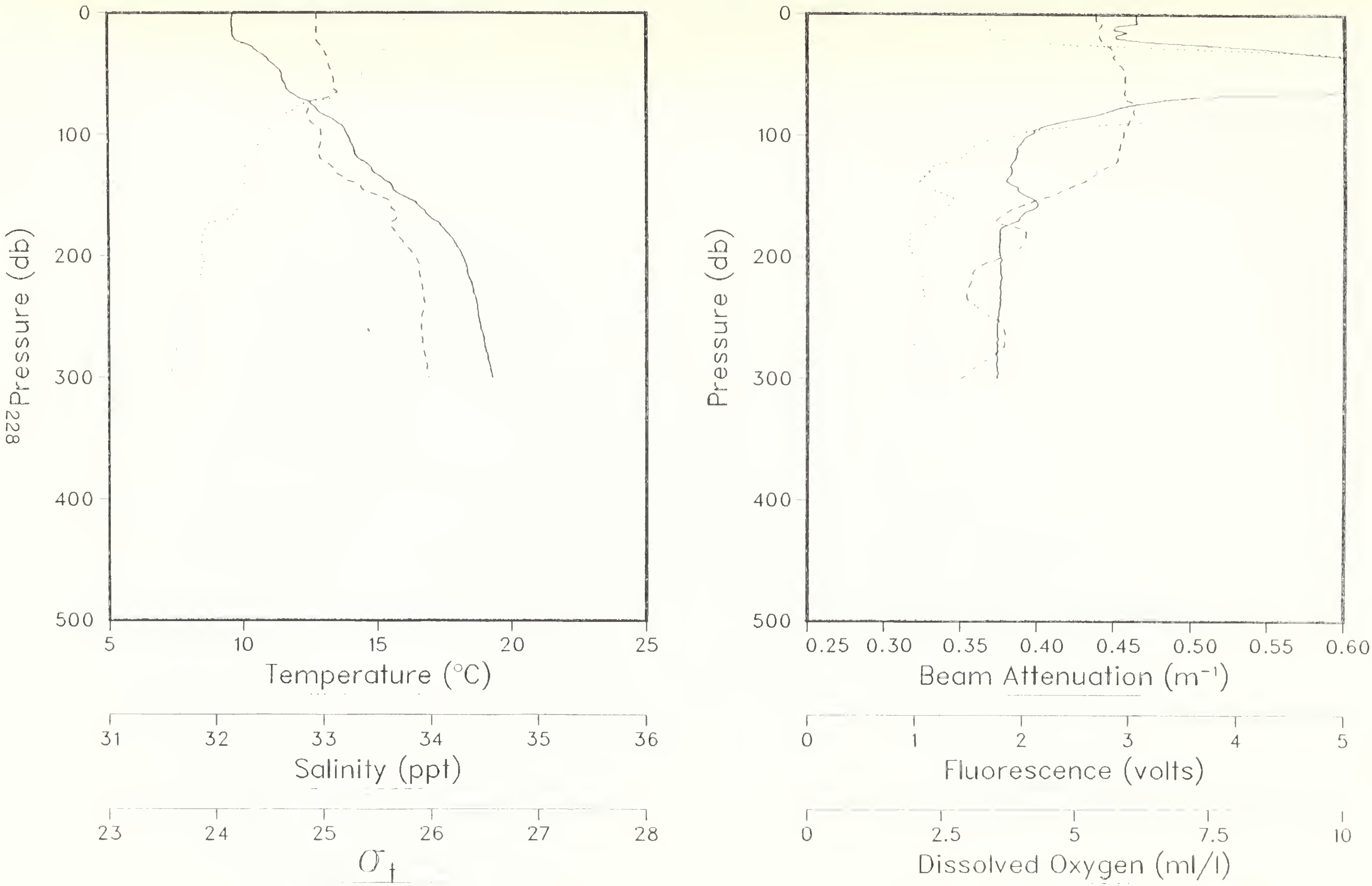




Latitude: 34.784°
Longitude: 127.209°

Date: 11/15/82
Time: 1818:20 GMT

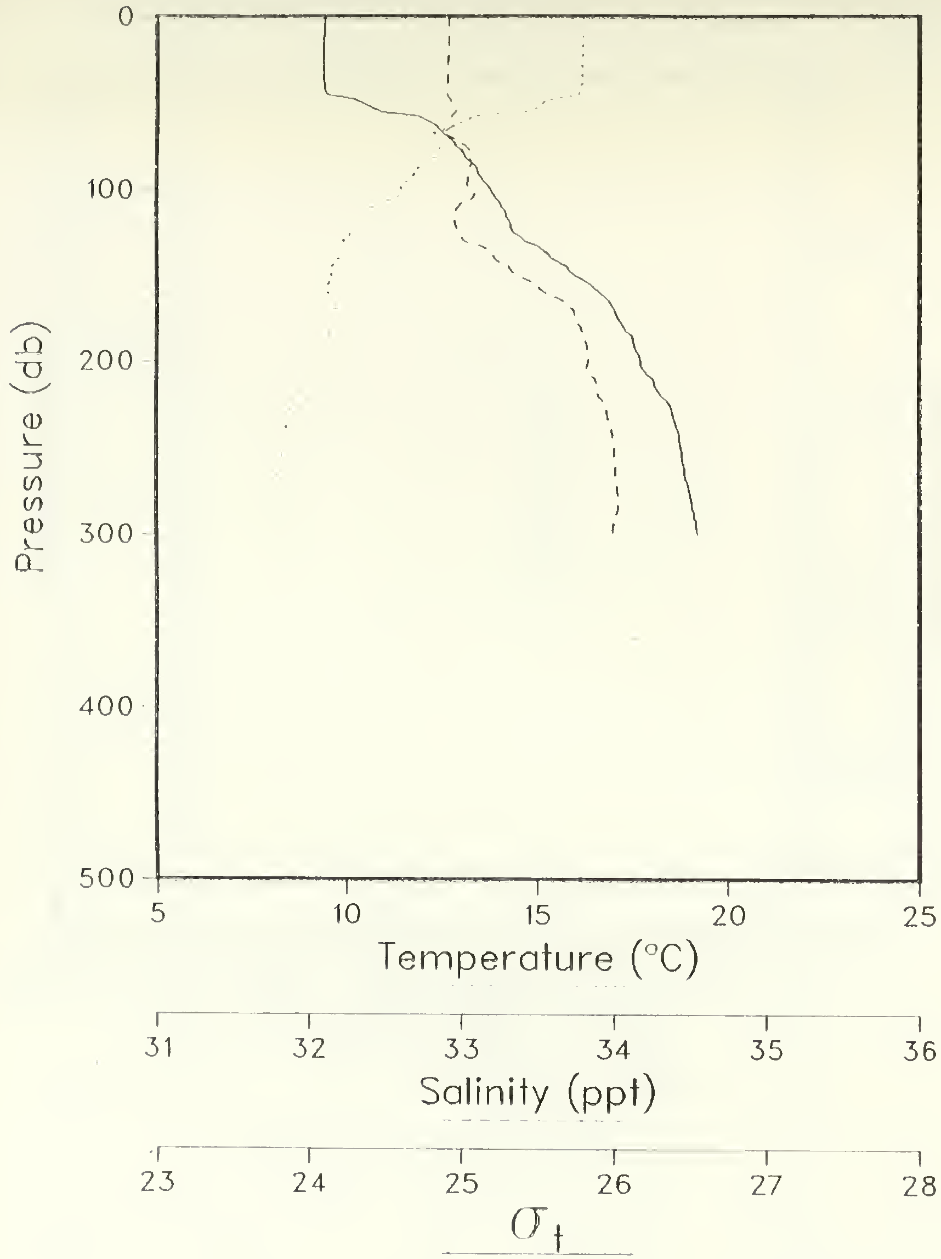
R/V ACANIA CRUISE ODEX3 STATION 170

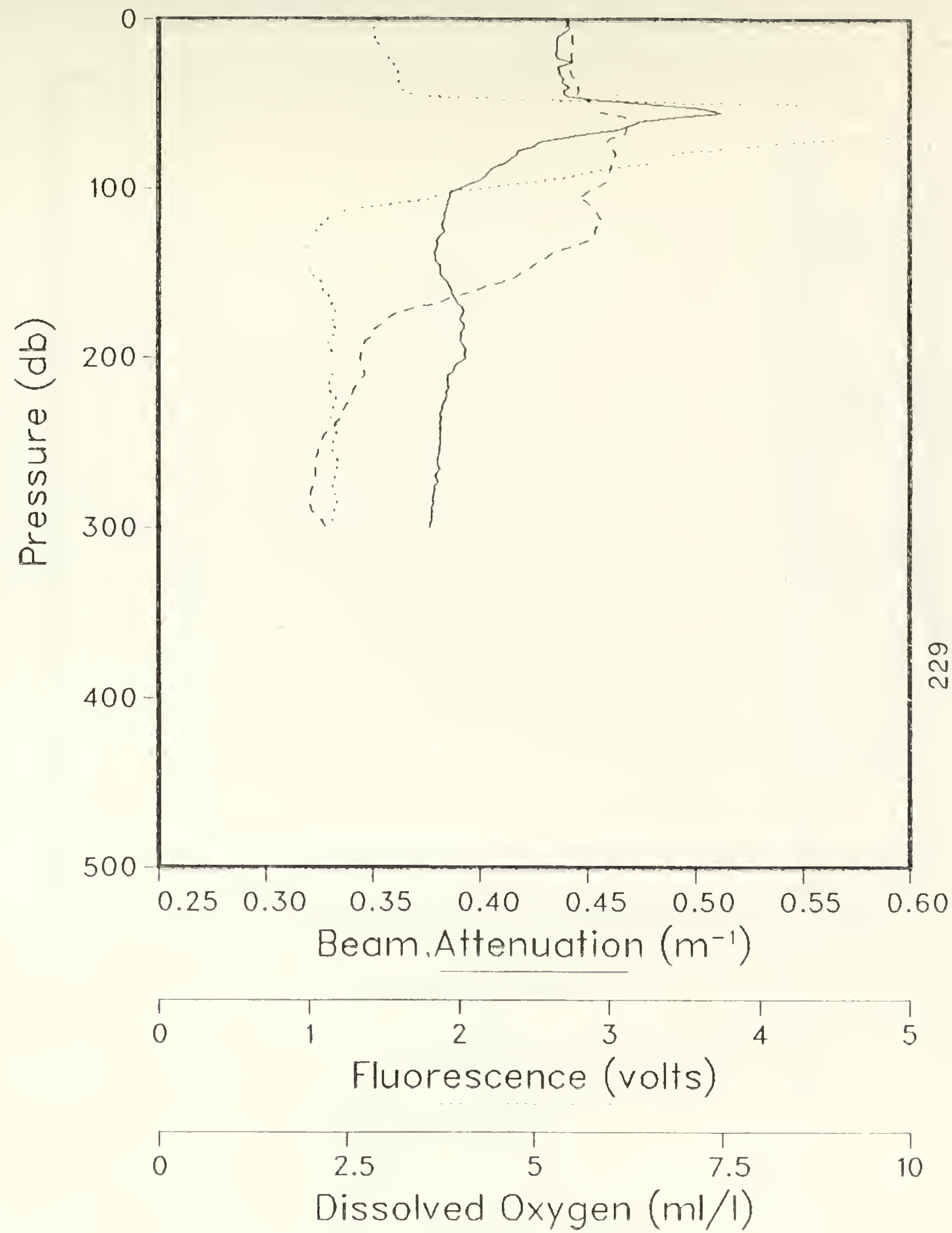


Latitude: 34.985°
Longitude: 124.990°

Date: 11/16/82
Time: 846:37 GMT

R/V ACANIA CRUISE ODEX3 STATION 171

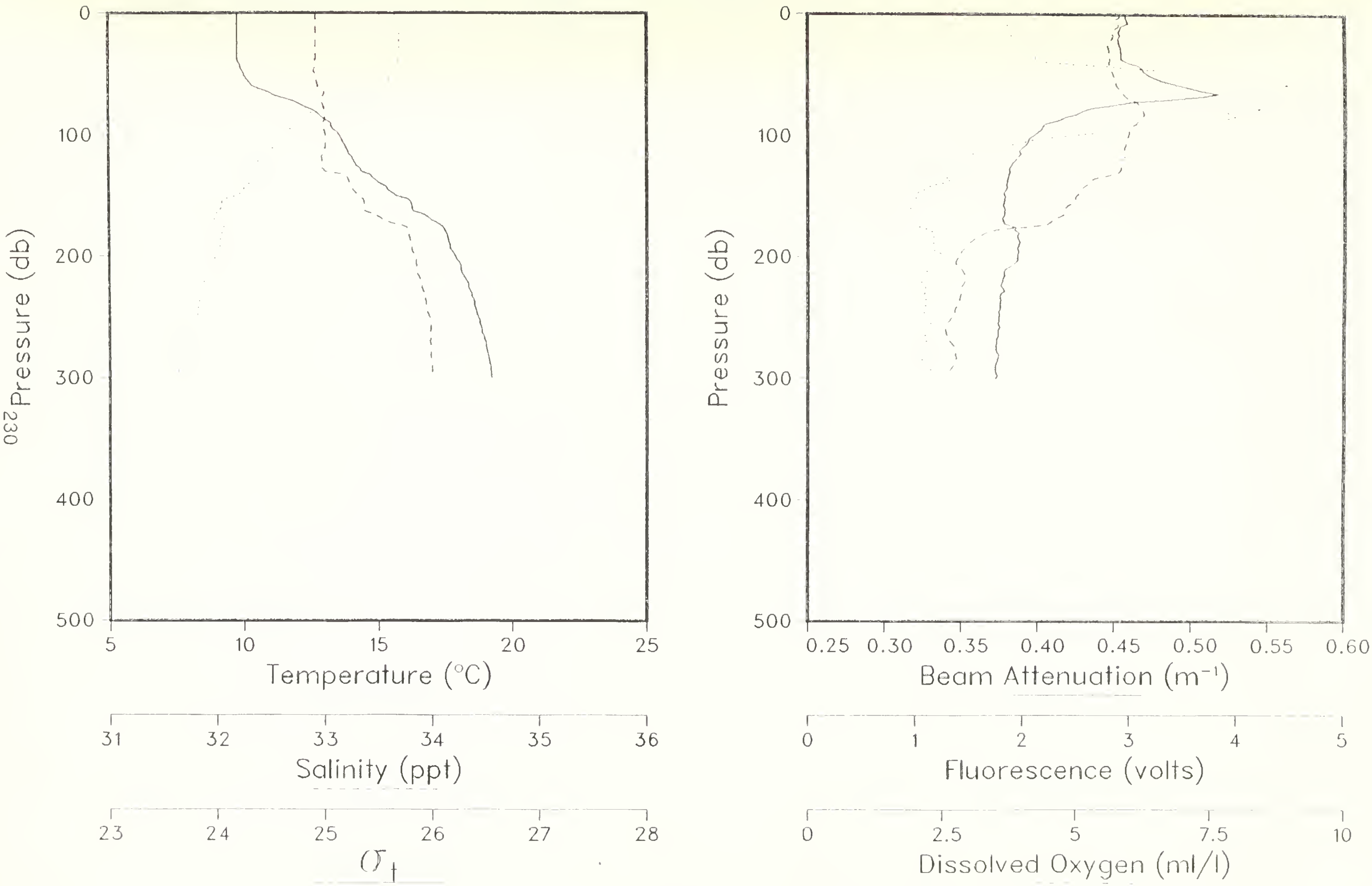




Latitude: 34.995°
Longitude: 124.713°

Date: 11/16/82
Time: 1053:38 GMT

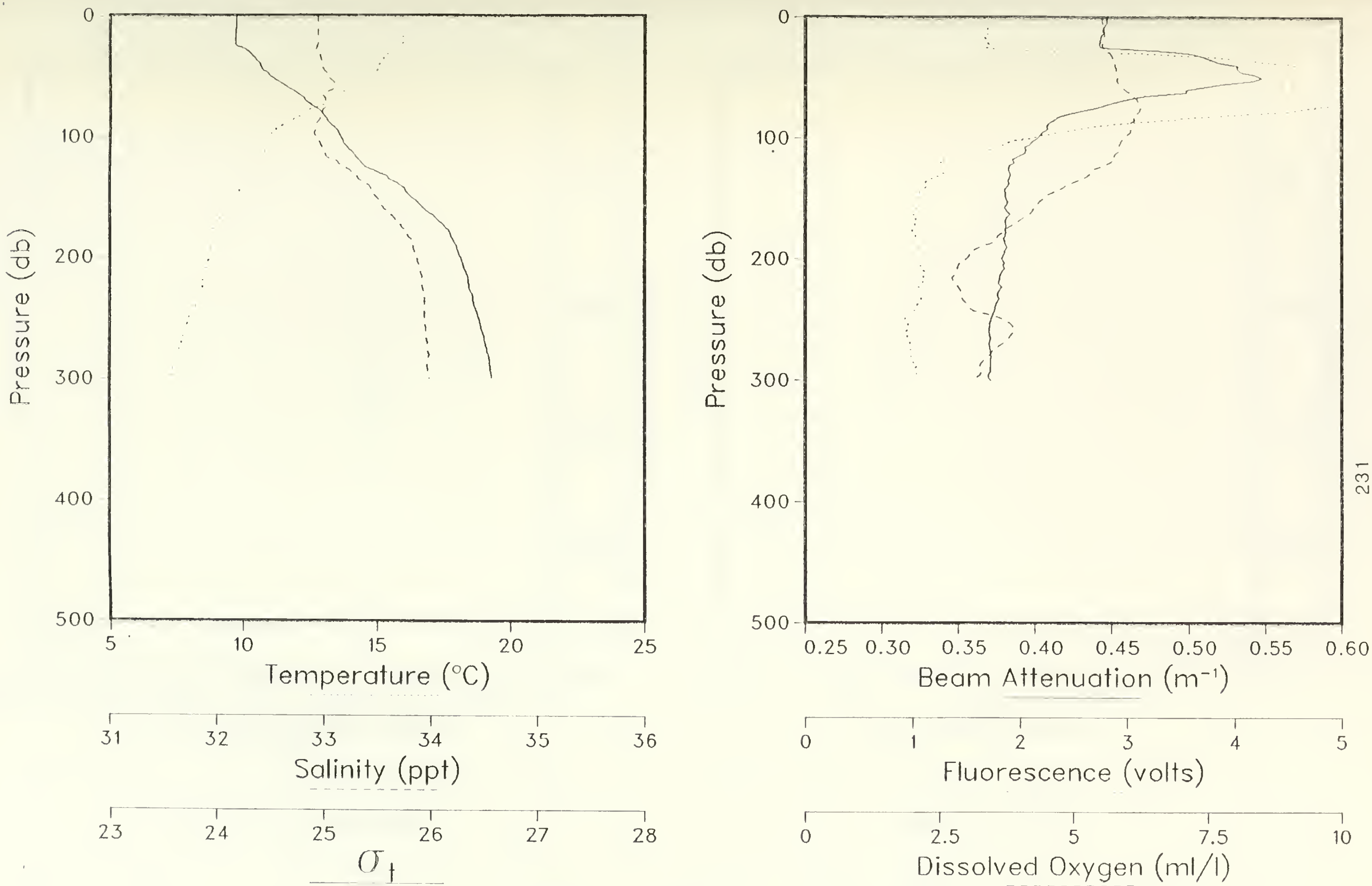
R/V ACANIA CRUISE ODEX3 STATION 172



Latitude: 34.994°
Longitude: 124.434°

Date: 11/16/82
Time: 1303:02 GMT

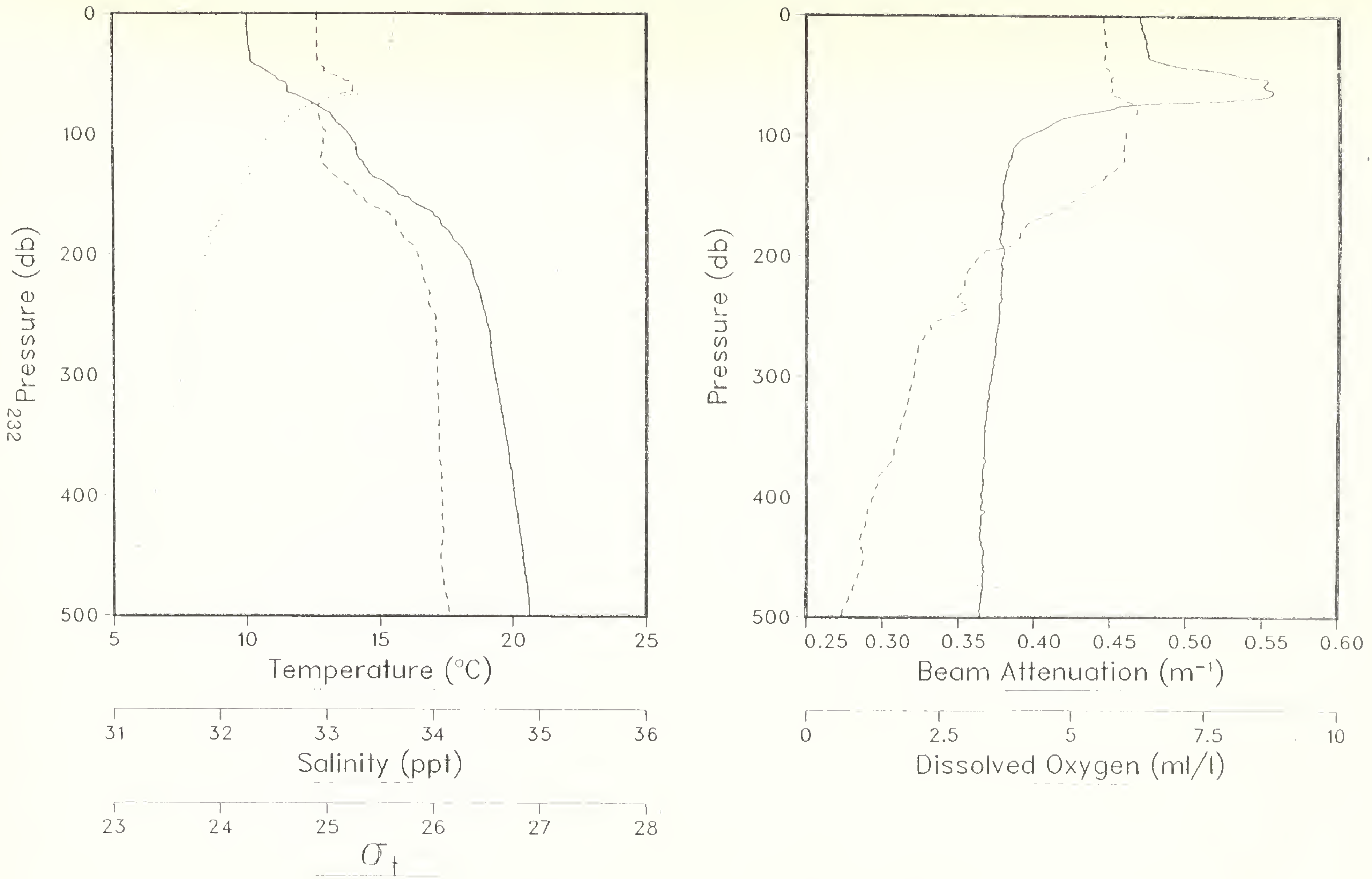
R/V ACANIA CRUISE ODEX3 STATION 173



Latitude: 35.006°
Longitude: 124.152°

Date: 11/16/82
Time: 1520:35 GMT

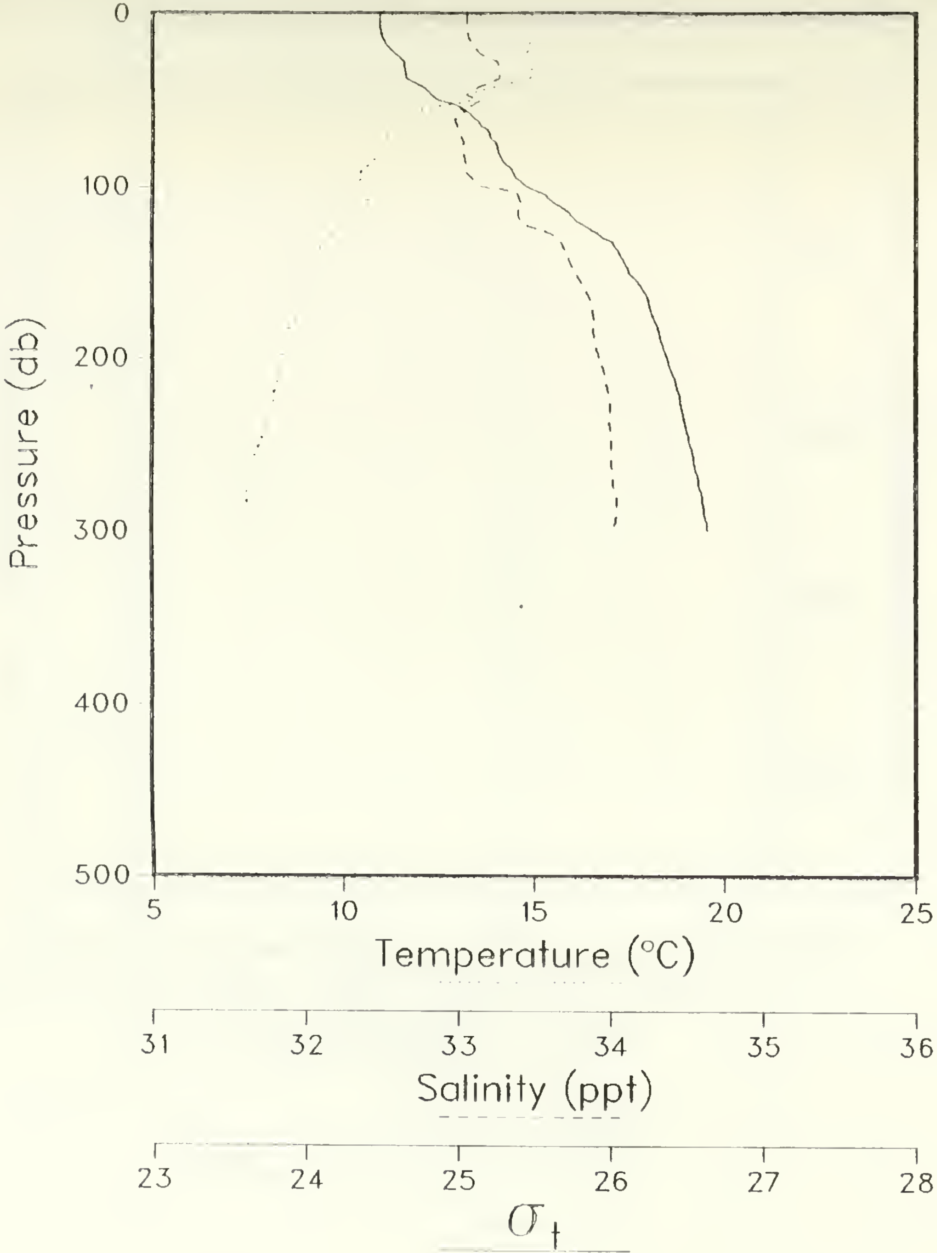
R/V ACANIA CRUISE ODEX3 STATION 174

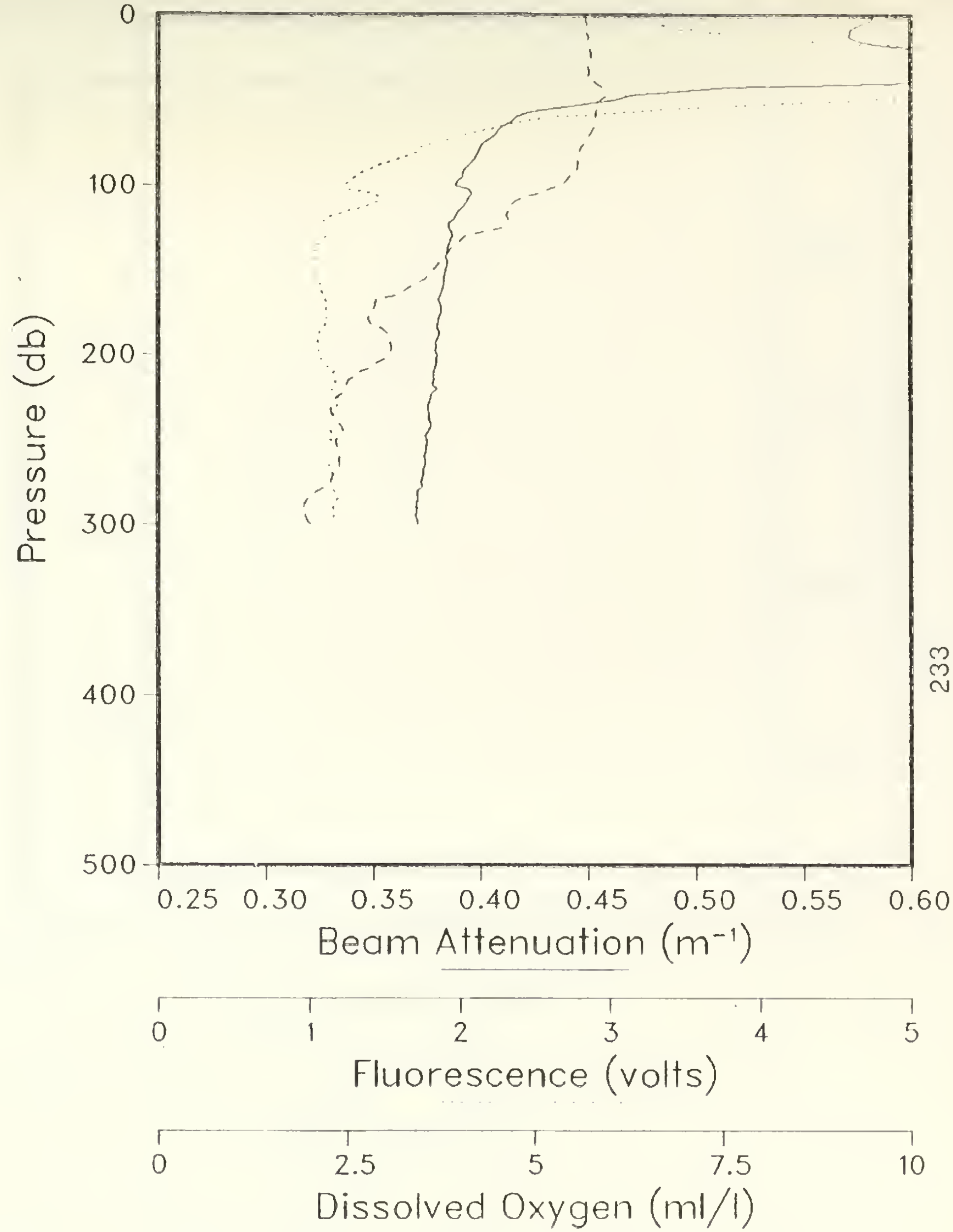


Latitude: 34.992°
Longitude: 123.879°

Date: 11/16/82
Time: 1916:41 GMT

R/V ACANIA CRUISE ODEX3 STATION 175

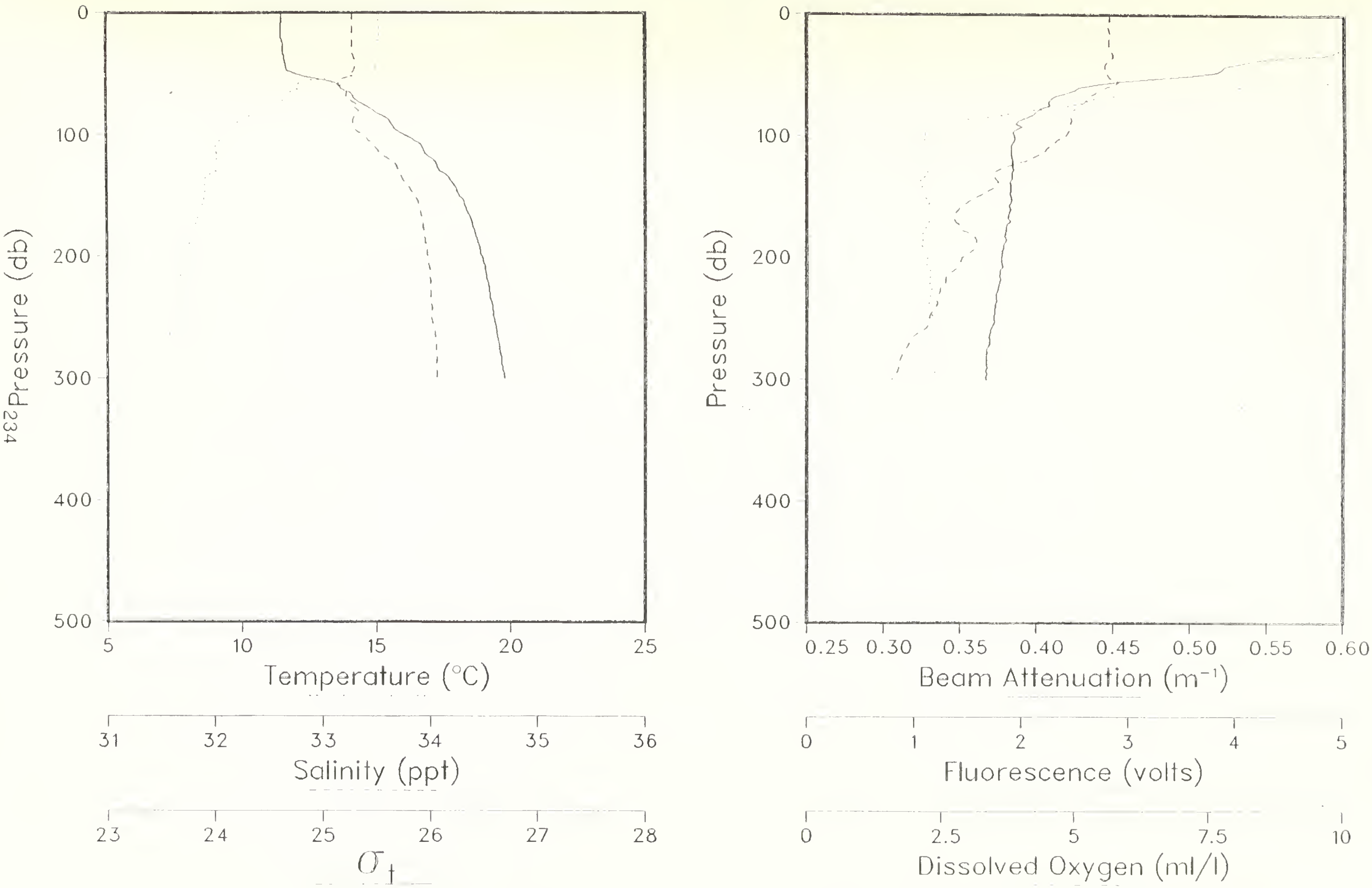




Latitude: 35.001°
Longitude: 123.596°

Date: 11/16/82
Time: 2346:37 GMT

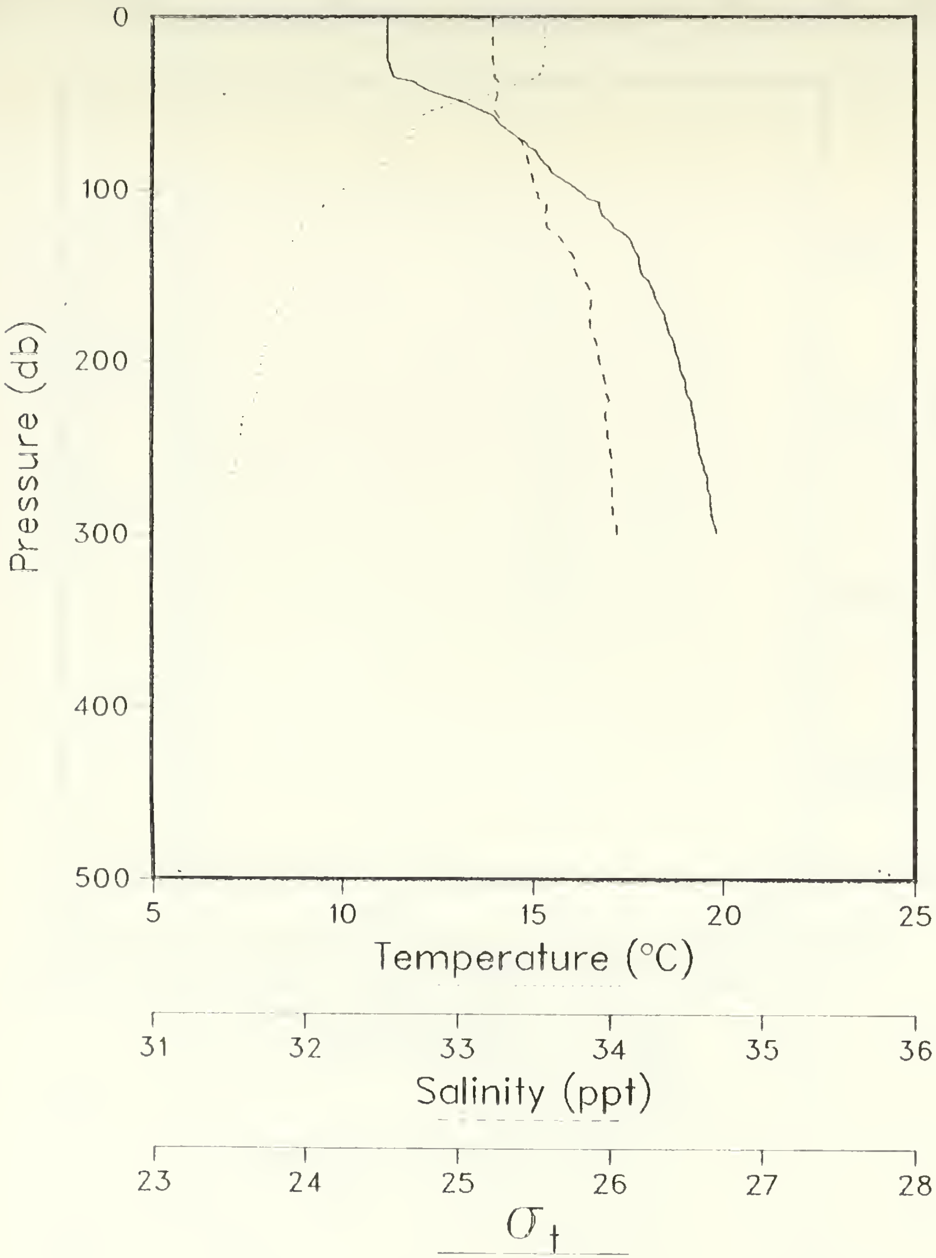
R/V ACANIA CRUISE ODEX3 STATION 176

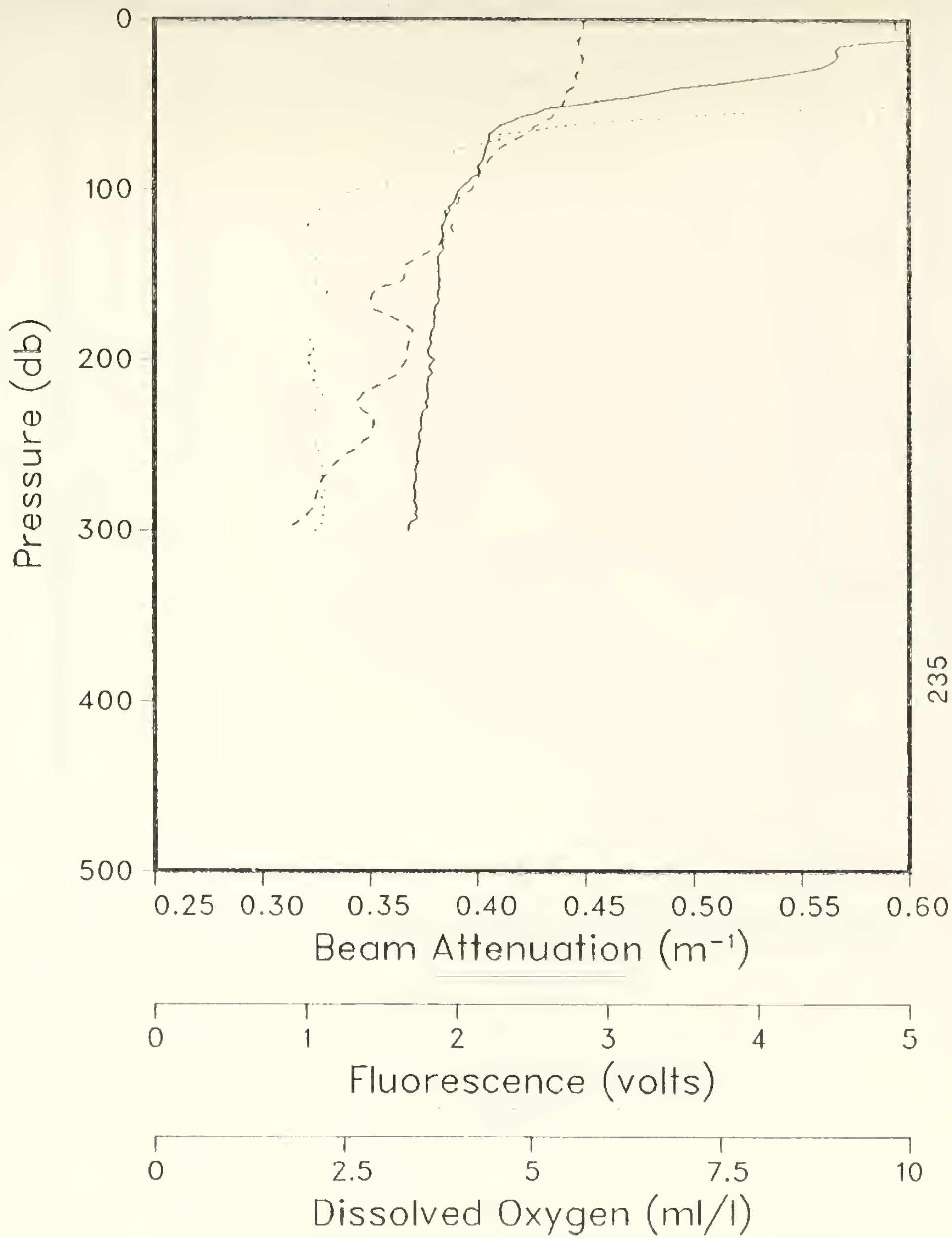


Latitude: 35.000°
Longitude: 123.306°

Date: 11/17/82
Time: 222:32 GMT

R/V ACANIA CRUISE ODEX3 STATION 177

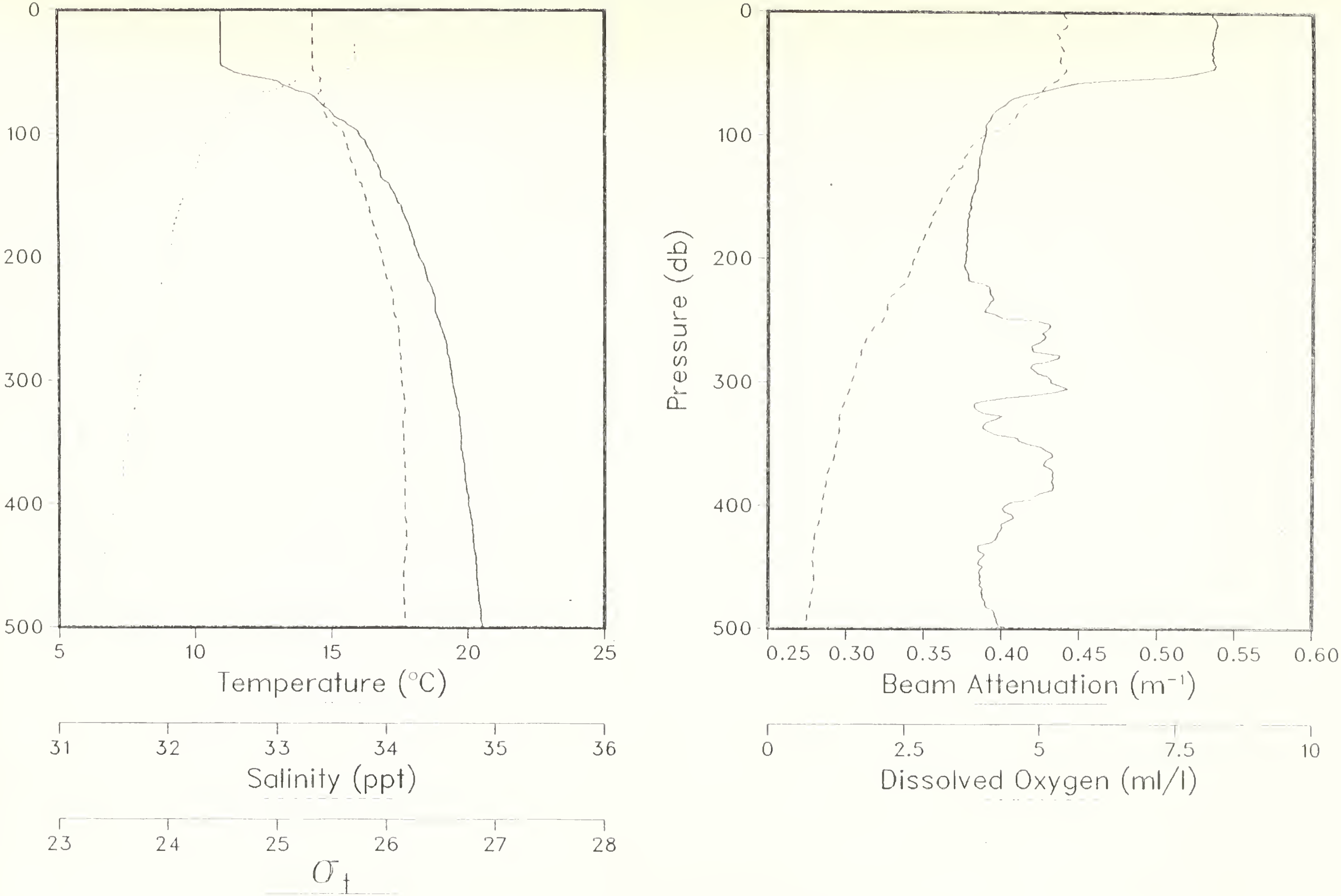




Latitude: 35.001°
Longitude: 123.023°

Date: 11/17/82
Time: 432:15 GMT

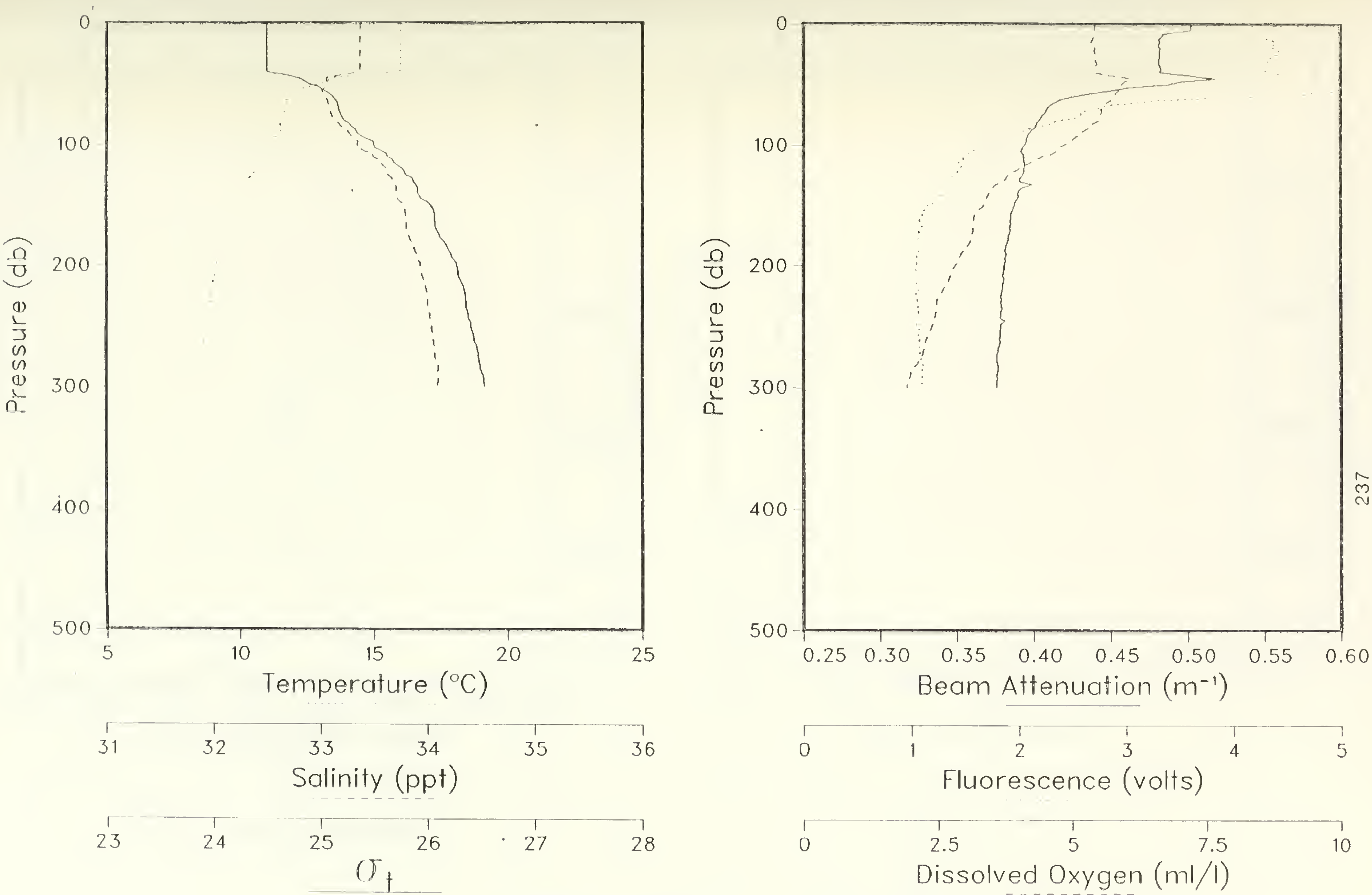
R/V ACANIA CRUISE ODEX3 STATION 178



Latitude: 35.888°
Longitude: 122.140°

Date: 11/17/82
Time: 1313:12 GMT

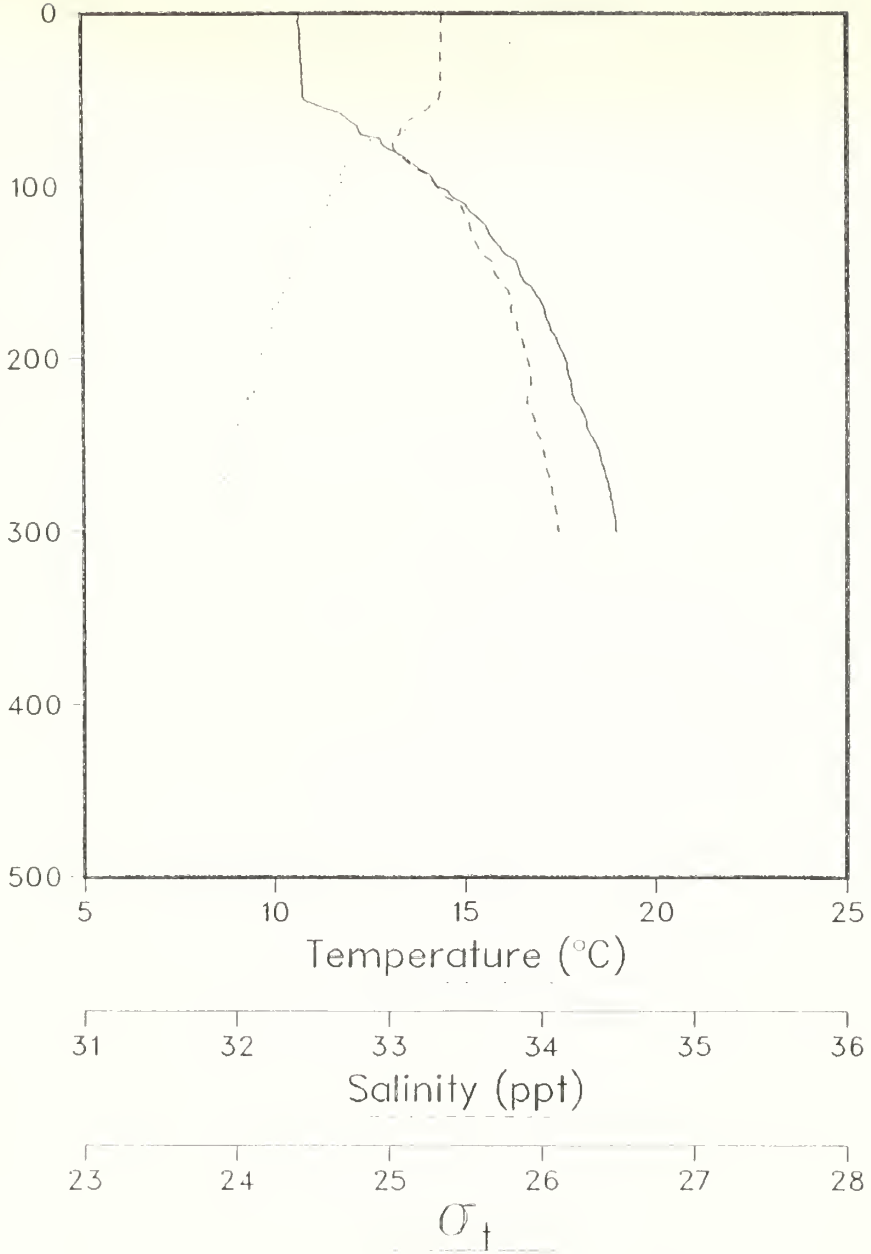
R/V ACANIA CRUISE ODEX3 STATION 179

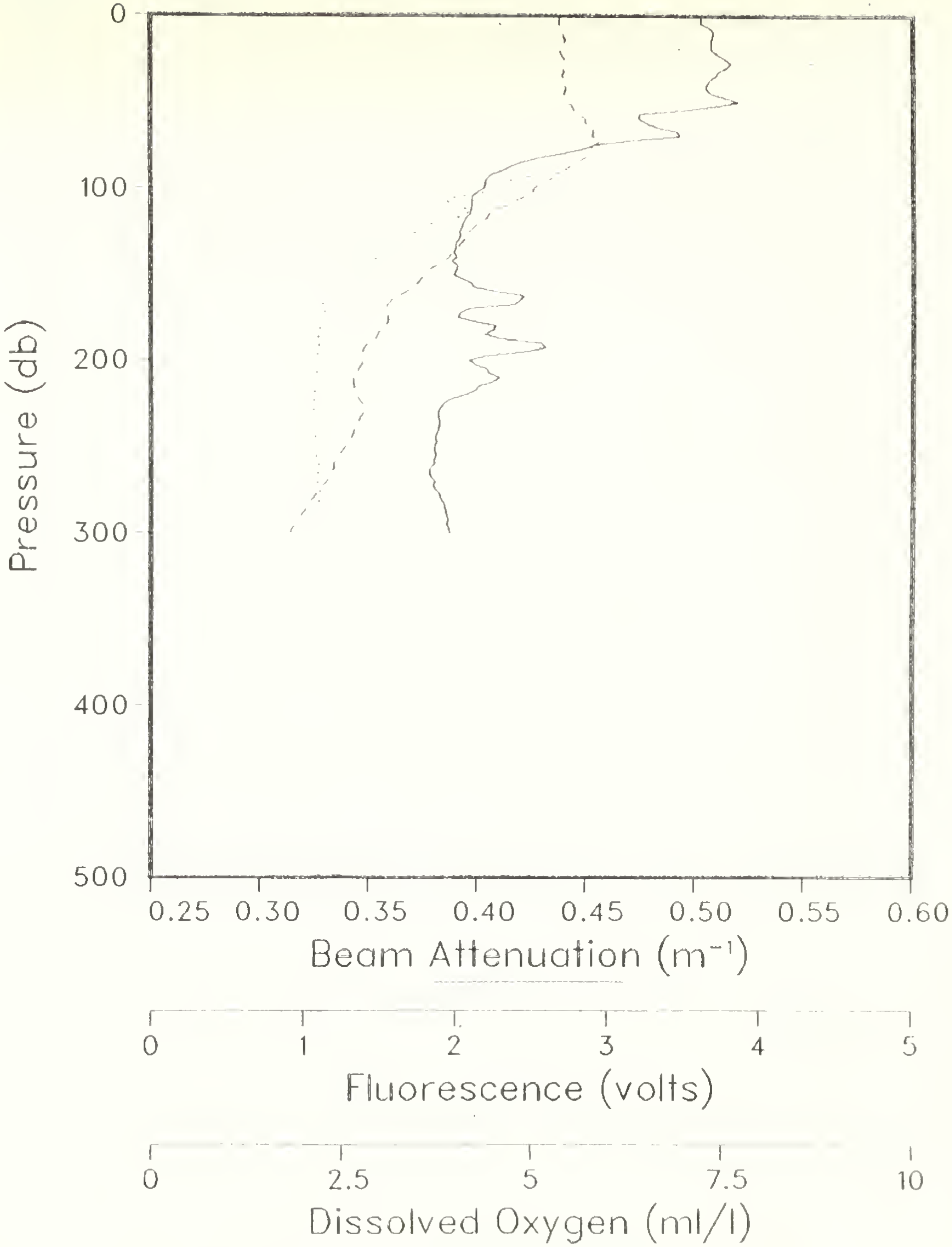


Latitude: [illegible]5.890°
Longitude: 121.934°

Date: 11/17/82
Time: 1610:18 GMT

R/V ACANIA CRUISE ODEX3 STATION 180

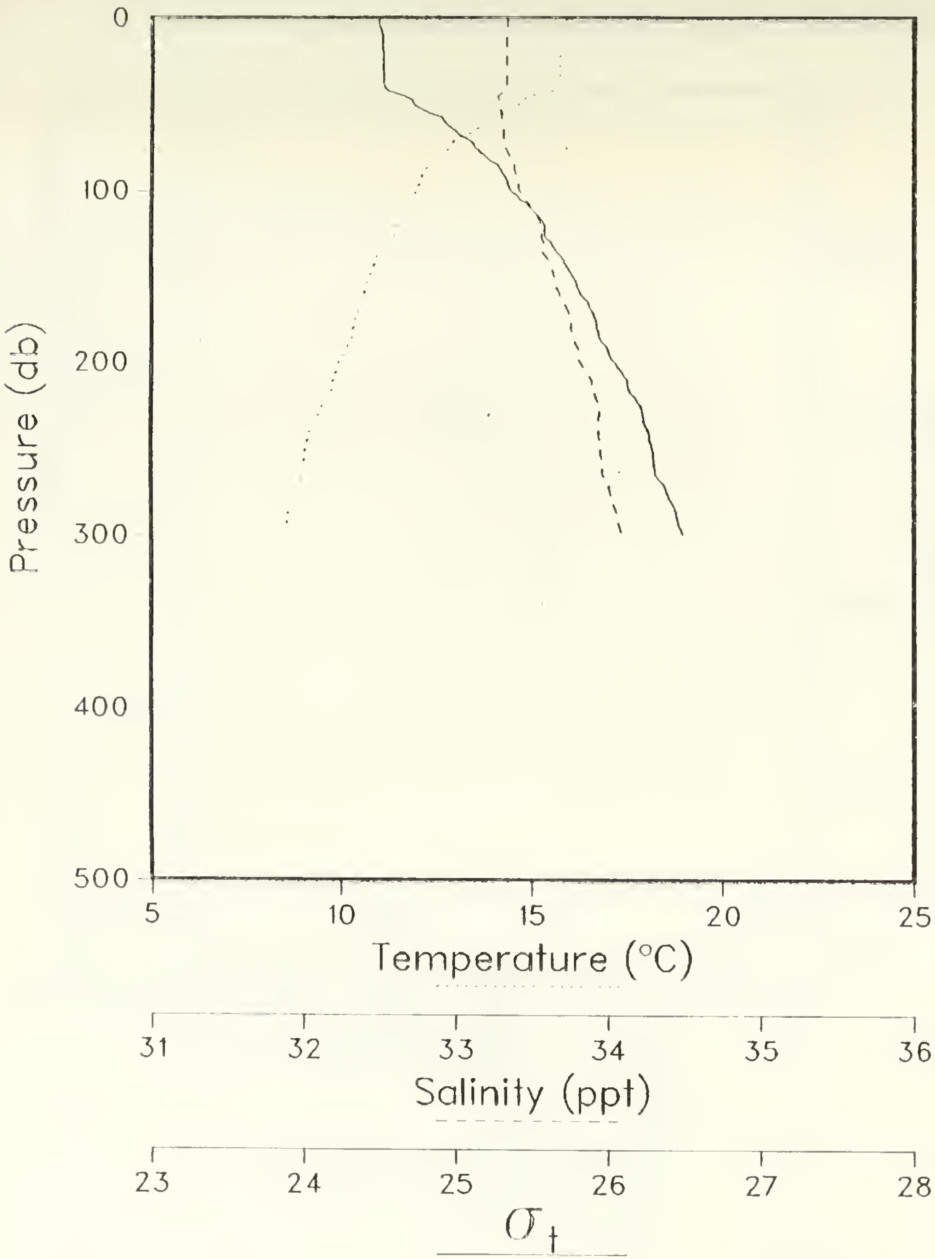


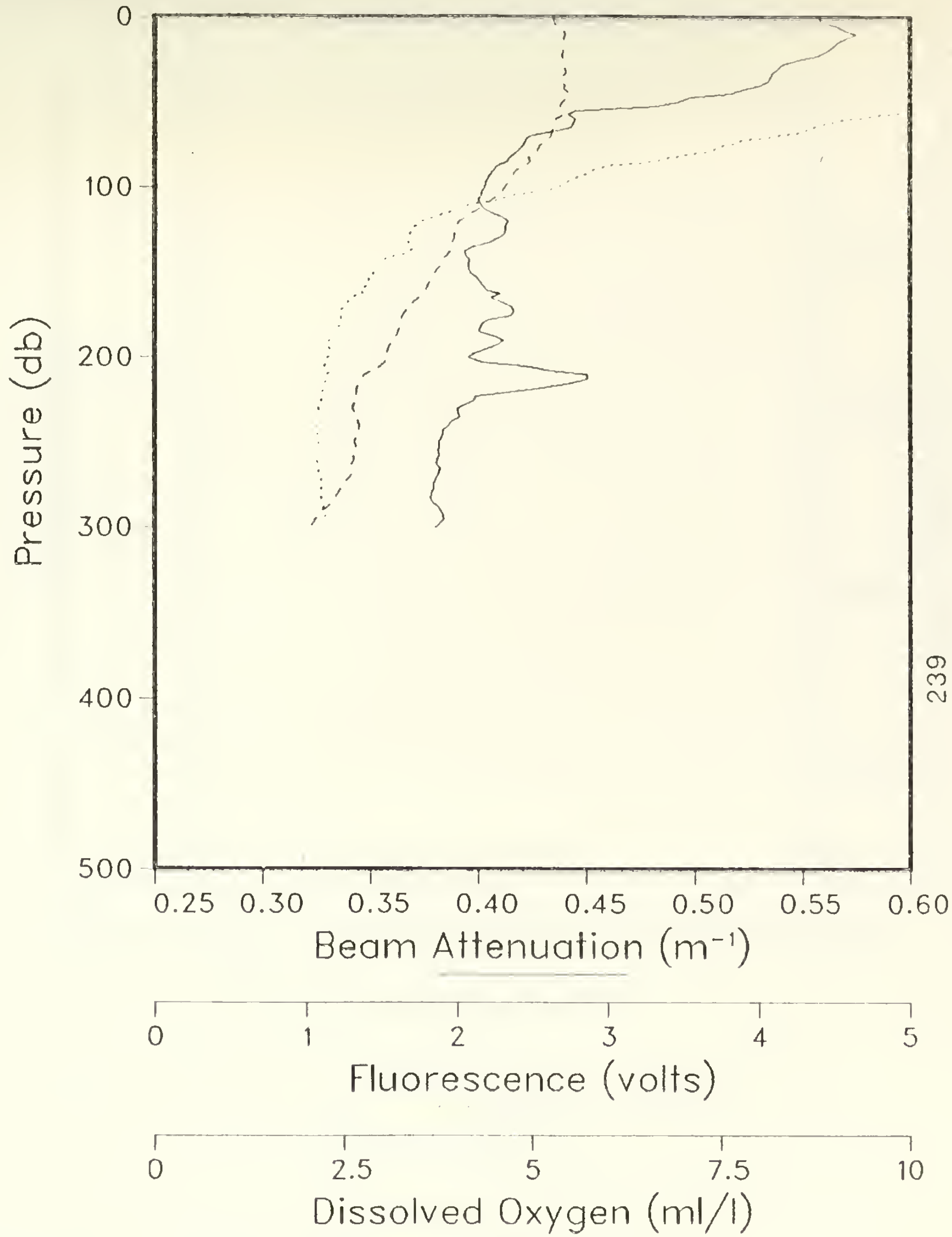


Latitude: 35.888°
Longitude: 121.735°

Date: 11/17/82
Time: 1910:55 GMT

R/V ACANIA CRUISE ODEX3 STATION 181

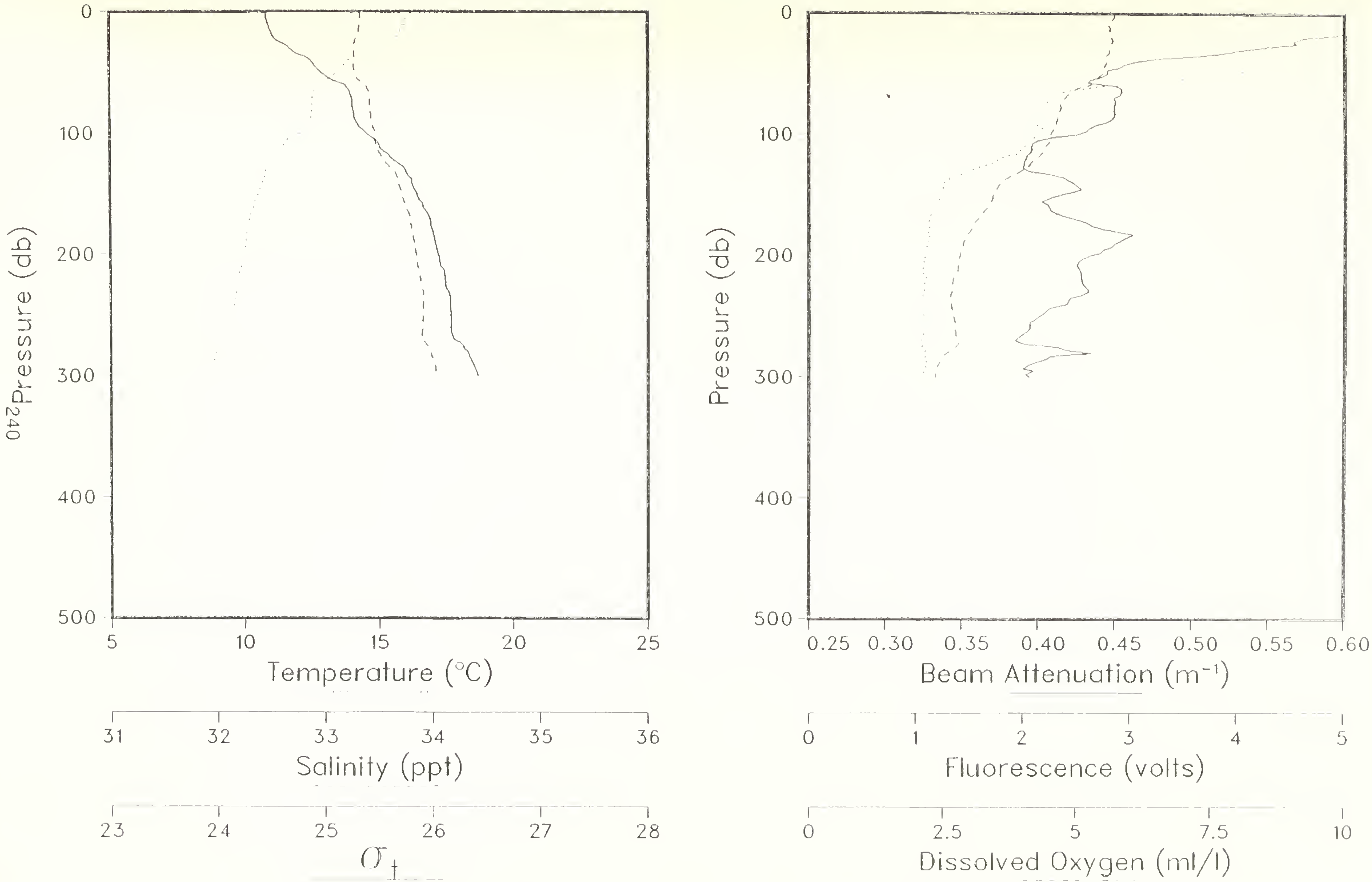




Latitude: 35.889°
Longitude: 121.653°

Date: 11/17/82
Time: 2051:33 GMT

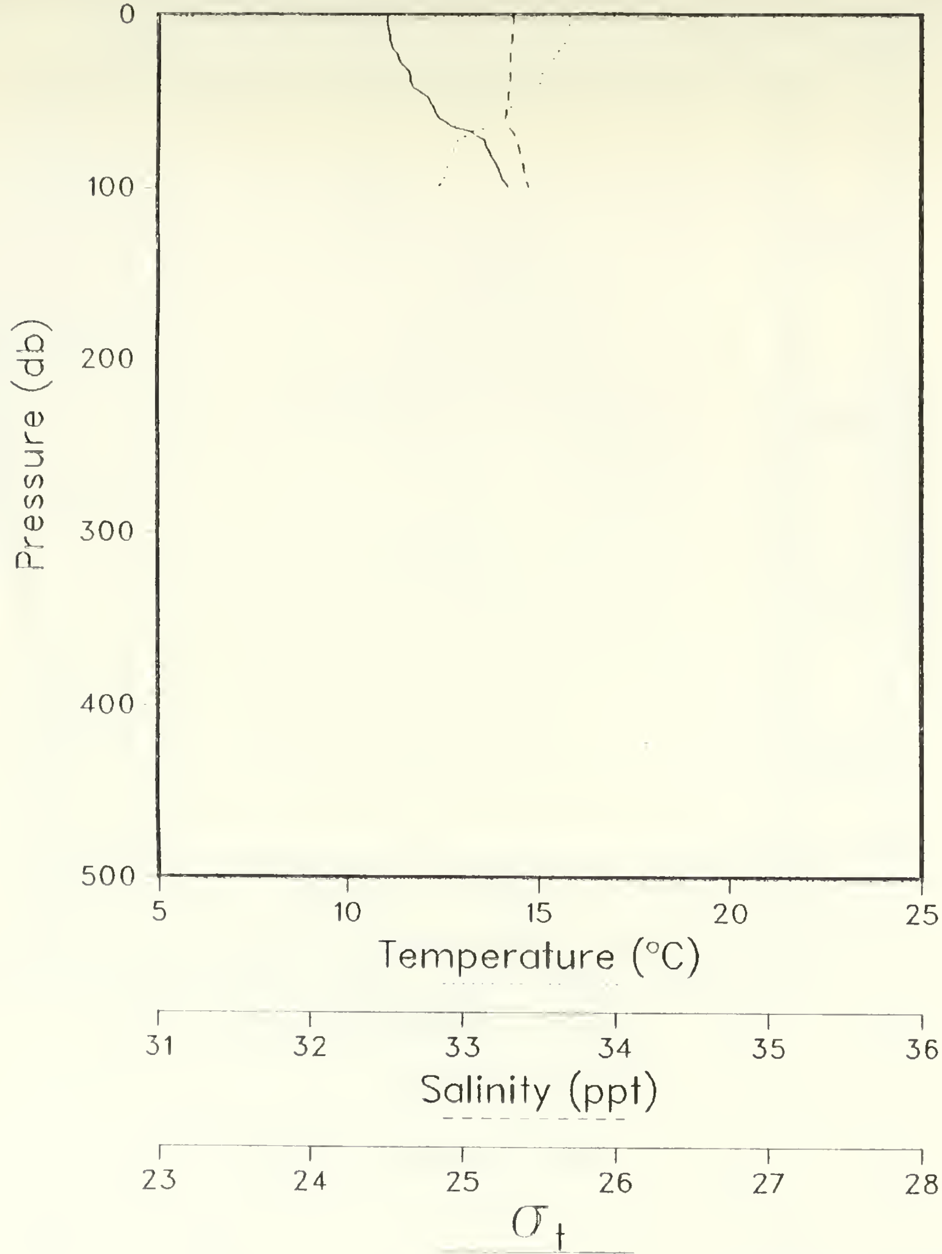
R/V ACANIA CRUISE ODEX3 STATION 182

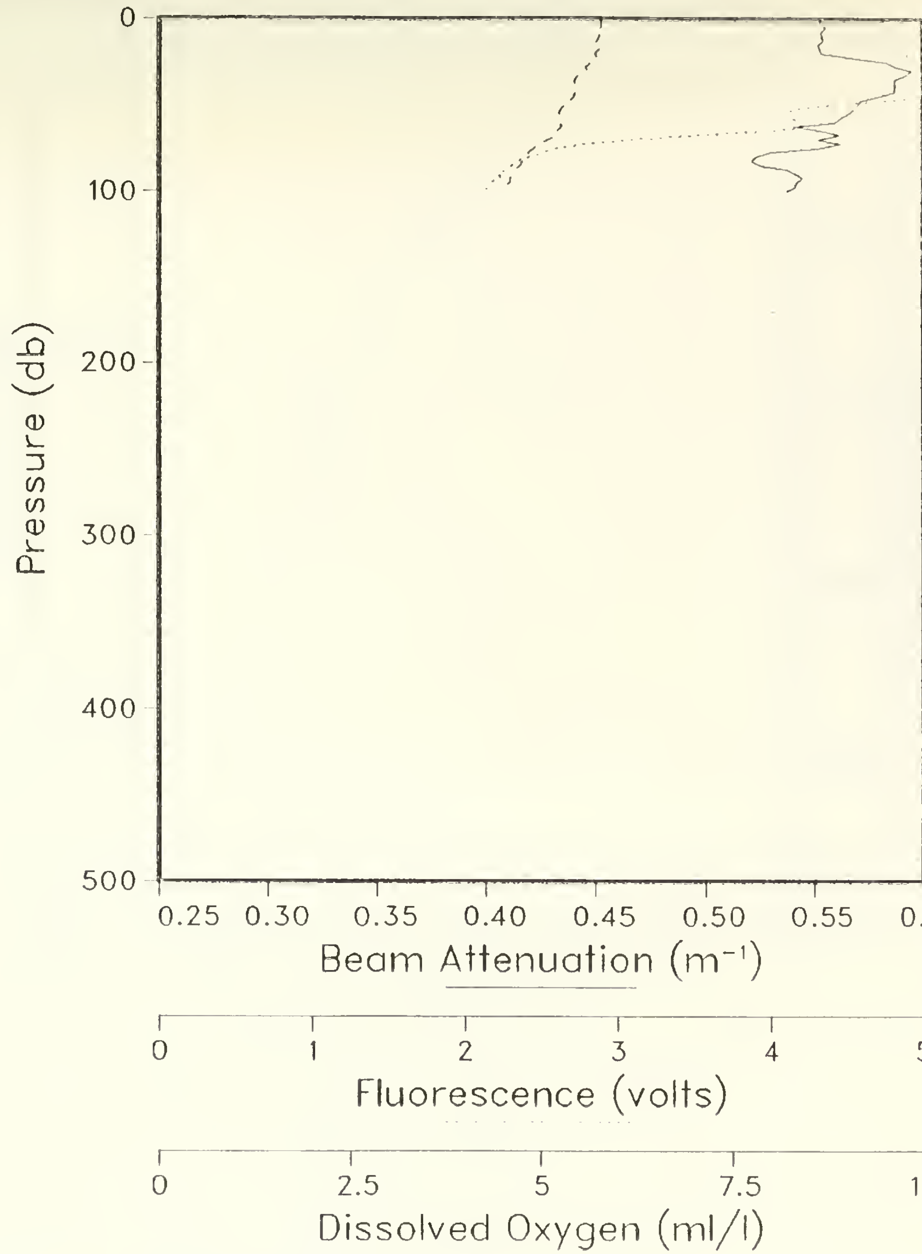


Latitude: 35.888°
Longitude: 121.569°

Date: 11/17/82
Time: 2238:07 GMT

R/V ACANIA CRUISE ODEX3 STATION 183





Latitude: 35.890°
Longitude: 121.517°

Date: 11/18/82
Time: 4:17 GMT

R/V ACANIA CRUISE ODEX3 STATION 184

5.0 ACKNOWLEDGEMENTS.

The success of this expedition depended heavily on the professional and willing contributions of Capt. W. W. Reynolds and the crew of the R/V ACANIA. Ms. Melissa Ciandro assisted in the final assembly and preparation of this data report. The scientific party aboard Acania during the ODEX expedition in 1982 consisted of:

J. Mueller	NPS
R. Zaneveld	OSU
R. Smith	UCSB
H. Pak	OSU
R. Bartz	OSU
D. Menzies	OSU
J. Stockel	NPS
J. Kitchen	OSU
E. Campbell	UCSB
G. Johnson	UCSB
G. Mitchell	USC
I. Sturgis	USC

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NOTES

APPENDIX A

R/V ACANIA STATIONS DURING ODEX (10 Oct. to 17 Nov. 1982)

STA #	DATE (GMT)	TIME (GMT)	LATITUDE (deg N)	LONGITUDE (deg W)	CTD	BOPS	OSU-K	TIP	C14
					--- number of profiles ---				
1	10/11	1630	35-54.00	122-10.00	equipment test				
2	10/11	2025	35-40.00	122-00.00	1				
3	10/11	2310	35-40.10	121-49.00	1	1	1		
4	10/12	0313	35-39.70	121-33.30	1				
5	10/12	0541	35-40.00	121-22.00	1				
6	10/12	1530	35-18.90	121-22.00	1				
7	10/12	1755	35-19.40	121-30.00			1		
8	10/12	1955	35-19.00	121-18.00		1	1		
9	10/12	2235	35-19.10	121-06.80	1	1	1		
10	10/13	0219	35-19.30	120-56.00	1				
11	10/14	1348	34-59.80	120-47.00	1	1			1
12	10/14	1605	35-00.00	120-56.20	1	1			
13	10/14	1841	35-00.00	121-04.90	1	1			
14	10/14	2114	35-00.00	121-13.00	1	1	1		
15	10/15	0017	35-00.00	121-23.90	1	1			
16	10/15	0253	35-00.00	121-31.00	1				
17	10/15	0510	35-00.11	121-39.19	1				
18	10/15	0715	34-54.97	121-48.08	1				
19	10/15	1530	34-59.95	122-42.40	1	1	1		
20	10/15	1943	34-59.97	122-59.93	2	1	1		
21	10/16	0002	35-00.00	123-13.90	1	1	1		
22	10/16	0704	34-56.78	123-58.02	1				
23	10/16	1400	34-59.93	124-51.47	1	1			
24	10/16	1740	35-09.75	124-51.86	1	1			1
25	10/16	2035	35-09.75	124-42.42	1	1	1		
26	10/17	0013	35-09.91	124-32.30	1	1			
27	10/17	0500	35-10.07	124-01.30	1				
28	10/17	0900	35-09.83	123-29.39	1				
29	10/17	1430	34-29.97	123-29.65	1	1			
30	10/17	1755	34-29.77	123-40.02	1	1	1		
31	10/17	2141	34-29.00	123-49.49	1	1			
32	10/18	0020	34-29.90	123-59.07	1	1			
33	10/18	0430	34-30.28	124-21.74	1				
34	10/18	0800	34-30.02	124-47.67	1				
35	10/18	1130	34-29.68	125-09.57	1				
36	10/18	1500	34-29.83	125-33.32	1	1			
37	10/18	1729	34-29.96	125-40.87	1	1	1		
38	10/18	2053	34-29.99	125-45.49	1	1	1		
39	10/19	0001	34-29.85	125-54.75	1	1			
40	10/19	0430	34-29.90	126-22.70	1				
41	10/19	0830	34-27.87	126-59.00	1				
42	10/19	1230	34-29.50	127-22.70	1				
43	10/19	1600	34-30.20	127-40.90	1	1			
44	10/19	2015	34-29.50	128-09.90		1	1		
45	10/20	0140	34-29.75	128-47.00	1				
46	10/20	1534	34-30.65	130-47.70	4	2	1		1
47	10/22	2055	34-12.31	134-22.36	1	1	1		

R/V ACANIA STATIONS DURING ODEX (10 Oct. to 17 Nov. 1982)
(continued)

STA #	DATE TIME (GMT)	LATITUDE (deg N)	LONGITUDE (deg W)	CTD	BOPS	OSU-K	TIP	C14
				--- number of profiles ---				
48	10/23 0704	34-11.73	135-32.00	1				
49	10/23 1800	34-13.66	136-37.77	1	1			
50	10/25 1800	33-58.70	140-51.30	1	1	1		
51	10/25 2340	34-01.28	141-08.98	1	1	1		
52	10/26 1100	33-44.70	141-53.25			8		
53	10/26 1540	33-34.33	141-51.90	1	1			1
54	10/26 1759	33-40.12	141-52.10	1	1			
55	10/26 2105	33-52.05	141-48.98	1	8			
56	10/27 0715	33-34.30	142-23.70		1	21		
57	10/27 1850	33-38.90	142-21.00		1			
58	10/27 2109	33-38.10	142-06.30	1	1	1		
59	10/28 0032	33-37.44	141-57.92	1	1			
60	10/28 0309	33-37.64	141-48.35	1				
61	10/28 0445	33-36.90	141-43.30	22	1			1
62	10/28 1910	33-46.22	141-27.25	1	1			
63	10/28 2140	33-44.70	141-17.60	1	1	1		
64	10/29 0055	33-43.69	141-08.71	1	1			
65	10/29 0310	33-45.00	141-02.00	11				
66	10/29 2014	33-33.43	141-38.92	1	1	1		
67	10/30 0002	33-21.78	141-42.04	1	1			
68	10/30 0240	33-13.94	141-39.17	1				
69	10/30 0435	33-05.91	141-43.08	1				
70	10/30 0615	32-58.02	141-41.10	1				
71	10/30 1101	32-33.50	141-38.90	1				
72	10/31 1700	31-24.50	141-35.19	1	1	1		1
73	10/31 2300	31-02.60	141-34.90	1	1	1		
74	11/01 0500	30-54.37	141-25.13	1				
75	11/01 1100	30-20.00	141-28.00	1				
76	11/01 1550	30-00.53	141-30.05	1				
77	11/01 1805	30-02.10	141-22.10	3	2	2		1
78	11/02 0905	30-01.10	140-50.90	1				
79	11/02 1700	30-56.16	140-52.00	1	1	1		
80	11/02 2301	31-23.00	140-50.90	1	1	1		
81	11/03 0500	31-52.23	140-48.27	1				
82	11/03 1101	32-28.30	140-50.10	1				
83	11/03 1700	32-53.22	140-52.95	1	1			
84	11/03 1930	32-59.46	140-47.84	1	1	1		
85	11/03 2300	33-05.04	140-48.05	1	1			
86	11/04 0140	33-13.83	140-52.53	1	1			
87	11/04 0410	33-20.89	140-45.57	1				
88	11/04 0620	33-27.12	140-47.77	1				
89	11/04 0907	33-34.70	140-51.20	1				
90	11/04 1056	33-42.40	140-50.00	1				
91	11/04 1252	33-50.60	140-54.90	1				
92	11/04 1437	33-56.26	140-46.00	1				
93	11/04 1705	33-49.97	140-57.55	1	1			1
94	11/04 1925	33-50.79	141-03.50	1	1			

R/V ACANIA STATIONS DURING ODEX (10 Oct. to 17 Nov. 1982)
(continued)

STA #	DATE	TIME (GMT)	LATITUDE (deg N)	LONGITUDE (deg W)	CTD	BOPS	OSU-K	TIP	C14
					--- number of profiles ---				
95	11/04	2230	33-49.50	141-15.00	1	1	1		
96	11/05	0115	33-40.70	141-15.50	1	1			
97	11/05	0316	33-34.70	141-15.48	1				
98	11/05	0457	33-28.00	141-15.00	1				
99	11/05	0620	33-22.80	141-17.10	1				
100	11/05	0816	33-16.80	141-11.60	1				
101	11/05	1027	33-07.40	141-16.90	1				
102	11/05	1215	33-00.70	141-12.80	1				
103	11/05	1405	32-53.08	141-17.14	1				
104	11/05	1600	32-46.65	141-15.58	1	1			1
105	11/05	1820	32-48.24	141-21.00	1	2	1		
106	11/05	2153	32-46.50	141-31.90	1	1			
107	11/06	0017	32-46.18	141-40.94	1	1			
108	11/06	0231	32-39.00	141-41.40	1				
109	11/06	0415	32-32.00	141-43.65	1				
110	11/06	0555	32-23.88	141-42.65	1				
111	11/06	0742	32-18.17	141-40.06	1				
112	11/06	0948	32-10.00	141-40.90	1				
113	11/06	1135	32-09.20	141-49.80	1				
114	11/06	1305	32-10.70	141-58.70	1				
115	11/06	1450	32-11.80	142-06.10	1				
116	11/06	1630	32-17.58	142-04.59	1	1			
117	11/06	1855	32-23.90	142-04.89	1	1			
118	11/06	2121	32-31.30	142-02.90	1	1			
119	11/06	2345	32-38.48	142-06.70	1	1			
120	11/07	0730	32-53.00	142-05.00	1				
121	11/07	1139	33-07.00	142-05.00	1				
122	11/07	1610	33-20.32	142-06.00	1	1			1
123	11/07	2000	33-27.70	142-05.30	1	1			
124	11/07	2309	33-35.40	142-06.00	1	1			
125	11/08	0150	33-35.38	142-14.95	1				
126	11/08	0328	33-35.60	142-23.10	1				
127	11/08	0510	33-28.52	142-22.92	1				
128	11/08	0710	33-20.48	142-20.72	1				
129	11/08	0851	33-13.00	142-21.40	1				
130	11/08	1035	33-07.00	142-22.00	1				
131	11/08	1206	33-00.00	142-22.00	1				
132	11/08	1359	32-58.25	142-15.40	1				
133	11/08	1612	33-00.15	142-05.35	1	1			1
134	11/08	1845	32-56.05	142-15.03	2	2	2	1	
135	11/09	0500	32-52.65	142-31.30	1				
136	11/09	0635	32-46.00	142-30.00	1				
137	11/09	0801	32-37.90	142-30.20	1				
138	11/09	0940	32-32.00	142-30.00	1				
139	11/09	1110	32-25.00	142-30.00	1				
140	11/09	1245	32-18.00	142-30.00	1				
141	11/09	1425	32-11.00	142-30.00	1				

R/V ACANIA STATIONS DURING ODEX (10 Oct. to 17 Nov. 1982)
(continued)

STA #	DATE (GMT)	TIME (GMT)	LATITUDE (deg N)	LONGITUDE (deg W)	CTD	BOPS	OSU-K	TIP	C14
					--- number of profiles ---				
142	11/09	1552	32-09.72	142-37.05	1	1			1
143	11/09	1835	32-10.90	142-46.70	1	1		1	
144	11/09	2128	32-07.40	142-56.10	1	1		1	
145	11/10	0032	32-15.80	142-58.10	1	1		1	
146	11/10	0320	32-25.00	142-55.00	1				
147	11/10	0501	32-32.00	142-55.00	1				
148	11/10	0628	32-39.80	142-55.37	1				
149	11/10	0755	32-46.90	142-57.30	1				
150	11/10	0915	32-53.20	142-53.00	1				
151	11/10	1220	32-53.00	142-30.00	1				
152	11/10	1403	32-53.32	142-18.73	1				
153	11/10	1545	32-52.07	142-07.75	1				
154	11/10	1725	32-51.70	141-56.96	1	1			1
155	11/10	1927	32-52.70	141-46.10	1	1			
156	11/10	2120	32-53.50	141-39.10	1	1			
157	11/10	2323	32-55.00	141-31.60	1	1			
158	11/11	0120	32-53.00	141-23.30	1				
159	11/11	0255	32-52.00	141-14.26	1				
160	11/11	0605	32-51.97	140-49.10	1				
161	11/11	0759	32-58.91	140-51.10	1				
162	11/11	0950	33-07.00	140-50.00	1				
163	11/11	1125	33-15.90	140-48.20	1				
164	11/11	1410	33-20.79	140-45.71	1				
165	11/11	1550	33-28.00	140-50.00	1	1			
166	11/11	1900	33-35.97	140-50.73		1			
167	11/12	2243	33-47.90	136-46.80		1	1	1	
168	11/13	1804	34-14.09	133-51.96	1				
169	11/14	1900	34-31.50	130 36.30	1	1			1
170	11/15	1800	34-47.06	127-12.51	1	1	1	1	1
171	11/16	0843	34-59.10	124-59.40	1				
172	11/16	1051	34-59.70	124-42.80	1				
173	11/16	1259	34-59.67	124-26.05	1				
174	11/16	1516	35-00.29	124-09.40	1	1			1
175	11/16	1803	35-00.30	123-52.50	1	2	1	1	
176	11/16	2226	35-00.03	123-35.77	1	2	1	1	
177	11/17	0217	34-59.99	123-18.48	1				
178	11/17	0428	34-59.91	123-01.33	1				
179	11/17	1305	35-53.28	122-08.38	1				
180	11/17	1606	35-53.37	121-56.08	1	1			1
181	11/17	1827	35-53.34	121-44.09	1	1		1	
182	11/17	2013	35-53.53	121-39.16	1	1	1		
183	11/17	2158	35-53.24	121-34.14	1	1		1	
184	11/17	2330	35-53.20	121-31.10	1	1	1		

APPENDIX B

INSTRUMENTS and DATA ACQUISITION SYSTEMS USED ABOARD the R/V ACANIA DURING ODEX

Several independent oceanographic instrumentation and data acquisition systems were used aboard Acania during the ODEX expedition in October and November 1982. The present volume of the ACANIA DATA REPORT (Volume 1) presents data only from the CTD subsystem (which includes data from the oxygen probe, optical beam transmissometer, and chlorophyll fluorometer) of the CTD/ROSETTE instrument package described below. On-board measurements made from water samples acquired with the CTD/ROSETTE package (phytoplankton pigment concentrations & interpolated profiles using the fluorometer, nutrient concentrations, particle volume distribution counts, and Carbon-14 productivity estimates) will be reported in subsequent volumes of the R/V ACANIA ODEX DATA REPORT (Oct/Nov 1982). Data acquired with the other profiling systems (BOPS, OSU-K, & TIP) will also be published in separate volumes of this data report.

CTD/ROSETTE SYSTEM.

This profiling system consists of a standard Neil-Brown CTD (Conductivity-Temperature-Depth) unit with their oxygen sensor and 16-channel digitizer options, a General Oceanics Rosette sampler configured for 12 5-liter Niskin bottles, a Sea-Tech beam transmissometer (with a 1-meter light path and a wavelength of 660 nm), and an in situ fluorometer (identical to that on BOPS but tuned for greater sensitivity at low levels of fluorescence and a correspondingly reduced full-scale saturation level). The fluorometer and transmissometer were mounted on the rosette, together with ten 5-liter Niskin bottles, and both instruments drew power from the CTD and passed their data through the 16-channel digitizer in the CTD. The Rosette and CTD were mounted within a large stainless steel cage for protection, with the CTD mounted below the rosette. Two complete units were carried by pooling equipment from OSU and NPS. The CTD used on each cast is coded on the archive tape as indicated in Appendix D.

Data from the CTD/ROSETTE system was recorded digitally on 9-track 1600 bpi tape through the DAS HP9835 on downcasts and upcasts, and for backup on downcasts only, the data were also recorded directly on audio tape and a digital Kennedy recorder. An Apple-][computer was interfaced to the CTD deck unit to display a sub-sampled (5 sec interval) real time profile of all parameters measured with this system on each downcast. These real-time outputs were used to select bottle sample depths on the upcasts, and to adapt our station grid as we began to discover the structure illustrated in the horizontal maps and vertical sections of hydrographic and optical variables presented in this report.

A total of 4 separate fluorometer configurations were used with the CTD/ROSETTE package on this cruise; the particular fluorometer

configuration for each cast is coded on the archive tape as described in Appendix D. Physically, these configurations include no fluorometer (deep casts), original serial numbers 12 & 13, serial number 11 (borrowed from the BOPS package), and a hybrid combination of components from both units S/N 12 & 13 which was assembled at sea after both pressure cases leaked and resulted in destruction of some components of each original instrument. Electronically, the above 4 fluorometer configurations were normally operated in a linear gain mode, but the hybrid unit (12 + 13) was operated in a logarithmic gain mode on some stations. The linear gains on units 12, 13 and (12+13) were set to give full scale (5 volt) response at the very low chlorophyll-a fluorescence levels we anticipated in the central gyre water masses; therefore, the data from these instruments saturate and fail to resolve structure in the chlorophyll maximum regions of coastal water masses, but give fine detail of structure in chlorophyll fluorescence profiles at offshore station. The linear gain on unit 11, on the other hand, was set to yield full scale output at relatively high levels of chlorophyll-a fluorescence, so that the BOPS fluorescence profiles show fine detail in chlorophyll rich water masses of the California Current system, but resolve structure at offshore stations with less resolution than units 12, 13 & (12+13).

O.S.U. K-METER.

The OSU K-Meter package consists of a Biospherical Instruments Irradiance meter, a beam transmissometer of (O.S.U. design) with a light path of 25 cm and a wavelength of 660 nm, and Sea-Bird Electronics Temperature and Conductivity probes. The irradiance meter has been modified to measure downward scalar irradiance, rather than vector irradiance which is usually measured with such instruments. This modification was accomplished by mounting a spherical diffuser over the receiver. The deck unit for this system consists of an Apple-][microcomputer and a printer, a configuration which allows on-line printouts of scalar irradiance at 12 wavelengths, temperature, salinity, density and beam attenuation (or alternatively transmission) as functions of depth.

BOPS (Bio Optical Profiling System).

The Bio Optical Profiling System was designed to rapidly obtain biological, optical, and physical data in the upper mixed layer of the ocean. The instrument package contains: two Bio-Spherical Instruments (BSI) 13 channel spectroradiometers, two specially constructed BSI two channel radiance instruments, a SeaTech transmissometer, Sea-Bird conductivity and temperature probes, an in situ fluorometer, a BSI total-quanta scalar irradiance meter, a depth transducer, and a 12 bottle rosette sampler. Data is transmitted from this underwater package up a single conductor CTD cable by means of frequency shift keying. The data from the unit is automatically logged by a computer on deck.

In addition to the underwater unit, BOPS contains a 13 channel deck spectroradiometer which simultaneously logs above surface irradiance while the underwater unit is recording data.

The BOPS system records the following parameters: downwelling, upwelling and above-surface spectral irradiance in thireteen ten nanometer channels (380, 410, 441, 465, 488, 520, 540, 560, 589, 625, 671, 694nm), total quanta between 350 and 700nm above and below the surface, upwelling radiance (441, 488, 520 and 550nm), beam transmittance at 670nm, in situ fluorescence, temperature and conductivity. All underwater parameters are recorded as functions of depth and the rosette is used to obtain water samples from selected depths in the water column.

TIP (Tethered Irradiance Profiler)

TIP is a system designed at NPS to measure upwelled and downwelled spectral irradiance away from the shadows and reflectances of any platform. This is accomplished by drifting the unit away from the ship on a surface float and then detaching it for free ballasted descent and buoyant ascent.

The TIP is a BSI spectral irradiance meter identical to the one on OSU-K, but configured in the standard way to measure vector irradiance at 12 wavelengths. The radiometer is mounted at one end of a rectangular aluminum frame, with an aluminum cannister mounted at the other end. Ordinary line floats (rated to 500 fathoms) are mounted to make the unit positively buoyant when the cannister is empty. In use, the cannister is filled with scrap lead in order to sink the unit. This makes the unit vertically stable in the water column, such that as it sinks, the irradiance collector looks vertically upward. The lead-filled cannister is tied to remain upright by a cord terminated at a simple pressure release device borrowed from the CAMEL system (courtesy of Dr. Rolf Lueck and Prof. Tom Osborne, both of NPS). At a nominal depth of 200 m, the cord is released, the bucket tips 180 degrees, the lead falls out, and the unit begins to ascend. The floats are free to move to either end of the frame, so that (in principle) the unit may be upended on ascent to measure upwelling irradiance. In practice, the unit tends to be marginally stable in either vertical position without lead in the cannister. The unit was successfully flipped on two casts by tugging hard on the tether when the unit was at 50 m on ascent, but more work is needed to assure reliable performance of this maneuver.

The TIP is tethered to the ship by a 1000 m Kevlar 4-conductor electro-mechanical cable used both for data acquisition and retrieving the instrument (especially should the pressure release fail). In the present configuration, the tether is hand tended and spooled onto a simple hand operated reel equipped with electrical slip rings.

The TIP data acquisition unit consists of an APPLE-][micro-computer, configured much like the one used with OSU-K, with the

exception that the data are recorded on the Acania's DAS 9-track, 1600 bpi tape unit.

ACANIA DAS (Data Acquisition System).

The ACANIA's Data Acquisition System consists of an HP-9835 micro- computer, together with: meteorological and oceanographic sensors; digital-to-analog converters, data scanners, frequency meters, etc. for data input to the computer; and with an HPIB interface to a 9-track 1600 bpi tape drive for logging high data rate devices (such as the 16-channel CTD). Parameters routinely recorded during ODEX include wind speed and direction, temperature and conductivity at 2 m (using Sea Bird sensors in the engine intake sea-chest), air temperature, dew point, humidity, pumped fluorometer output (for along-track chlorophyll concentrations), and 3 channels of incident solar irradiance from 2 pyranometers and a scalar quantum-meter. Two-minute averages of these variables were routinely logged, together with ship's gyro heading and position (when Loran-C was available) on HP-9835 data cassettes.

The DAS was used, while on station, to log 16-channel CTD records on 9-track 1600 bpi IBM compatible magnetic tape.

The DAS was used to digitally log each XBT profile on a data cassette file.

UCSB ALONG-TRACK SYSTEM.

A second along-track data acquisition system was provided by UCSB (RCS) as a backup to DAS. Some back-up meteorological and oceanographic sensors were installed and used with this system, which additionally provided plumbing and pumps for along track fluorometer and transmissometer measurements. The UCSB system recorded the same oceanographic and meteorological parameters logged by DAS (but as 1 minute averages), but not the ship's heading and navigation data. In addition to DAS parameters, the UCSB system routinely logged spectral irradiance data from the BOPS deck unit.

CHLOROPHYLL APPARATUS.

Turner Designs bench fluorometers, together with filtration and extraction apparatus, for phytoplankton pigment concentration analysis were provided by UCSB (RCS). Chlorophyll-a and phaeophytin samples were filtered and analysed at sea using the procedures described in Smith, et al (1981). The data will be edited and compiled for inclusion in Volume 3 of the ACANIA ODEX DATA REPORT.

BIOLOGICAL PRODUCTIVITY APPARATUS.

A deck incubator and Carbon-14 innoculation and filtration apparatus were provided and operated by the University of Southern California. These samples are being analysed at USC to calculate productivity profiles at 17 of the Acania's scientific stations (Table 1). Productivity estimates will be included in Volume 3 of the ACANIA ODEX DATA REPORT. This service is being provided under a contract between USC and OSU.

AUTO-ANALYSER.

A 5-channel nutrient autoanalyser was provided and operated by the University of Southern California under contract with OSU. This equipment was used to measure concentrations of phosphate, silicate, nitrate, nitrite and ammonia from all water samples at each scientific station. These nutrient profiles will be included in Volume 4 of the ACANIA ODEX DATA REPORT.

NOTES

Appendix C

Instrument Calibrations

CTD Temperature Calibration

A pre-cruise temperature comparison was performed between the two Neil Brown CTD's and the two Sea Bird temperature probes used during the cruise. The four instruments were placed in a well-stirred water bath which was cooled to near zero C, then allowed to warm passively to room temperature. Results are plotted in figure C1.

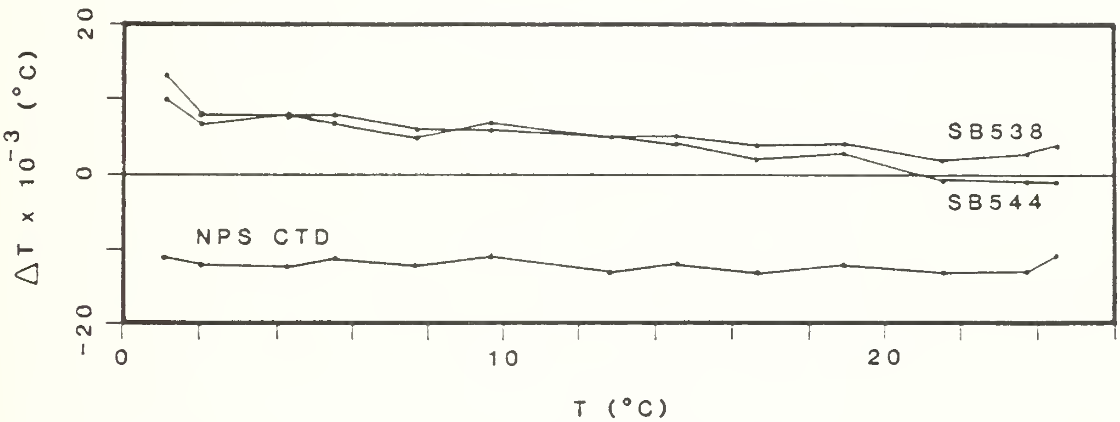

Figure C1. Delta T vs. T (degrees C.) relative to the OSU CTD.

In post-cruise data analysis the OSU CTD, which had been calibrated recently, was assumed to be to be most accurate. Therefore a bias correction is applied to temperature data from the NPS CTD based on the average difference between the two instruments (Delta T(ave) = +0.012 +/- 0.0008 degrees C).

CTD Conductivity Calibration

Conductivity calibration curves for the two CTD's were generated from in-situ salinity samples taken with the rosette water sampler. Water samples were analyzed with a Guildline Autosal standardized with I.A.P.S.O. standard

water, then salinities and in-situ conductivities of the water samples were calculated using a PSS78 based algorithim. These in-situ conductivities were used with conductivities measured by the CTD's to calculate a linear calibration curve for each instrument. Eight samples from one station were used to generate the curve for the OSU instrument, and nine samples from another station were used to generate the curve for the NPS instrument. Sample data and calibration curves for each instrument are plotted in figure C2.

The corrected conductivity for the NPS CTD was obtained as C = Cm * 0.99921 + 0.0128 mmhos, and that for the OSU CTD as C = Cm * 1.00029 - 0.0130 mmhos, where Cm is measured conductivity, and C is corrected conductivity. The rms errors associated with corrected conductivities are +/-0.0019 mmhos and +/-0.0013 mmhos for the NPS and OSU CTD's respectively

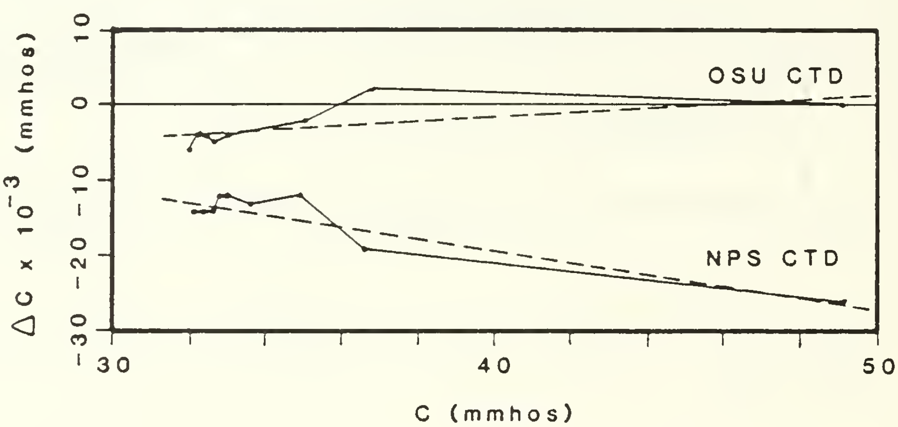

Figure C2. Delta conductivity vs. conductivity (mmhos), relative to bottle samples analyzed with a Guildline Autosal. Dotted lines show calibration curves derived from the sample data.

Transmissometer Calibration

A calibration curve for the Sea Tech 1 meter path length transmissometer can be generated from two data points. A full scale point is determined by measuring the instrument output voltage with the light path open to air. The zero point is obtained with the light path completely blocked. The two voltages obtained are then scaled by a factor relating the full scale output in air to the full scale output in pure water. The calibration equation is the y = m

* x + b, where y is % transmittance, x is voltage, m = 100 * (factory air cal. * water cal.) / cruise air cal., and b = dark voltage * water cal (Zaneveld and Bartz 1978) The cruise air cal. and dark voltage were constant throughout the cruise, giving m = 102.0537, and b = .04979. Particle size distributions from in-situ water samples were used to verify this correction. From the particle size distributions, an additional offset was found for those stations where a fluorometer was used with the NPS CTD. The total offset for these stations was +0.5246.

CTD Oxygen Calibration

In-situ oxygen samples taken with the rosette sampler and analyzed by a modified Winkler method were used to calibrate the Beckman polargraphic dissolved oxygen sensor on the NPS CTD. Data from an identical sensor on the OSU CTD was discarded after attempts to fit it to in-situ oxygen data failed. On the archive data tape, this data has been replaced with zeros. Thirty-four samples from six stations were used to fit a calibration curve to data from the NPS CTD. Relative oxygen concentrations were calculated from oxygen probe current, probe temperature and water temperature at the depths and stations where water samples were taken, then absolute concentrations were calculated from relative concentrations and theoretical saturation concentrations. Absolute oxygen concentrations based on CTD data were compared to absolute concentrations from titrated water samples, then the slope factor of the relative oxygen concentration equation was adjusted to make the CTD data fit the bottle sample data. The rms error associated with corrected oxygen concentration is +/-0.049 ml/l. Data points and curve are plotted in figure C3.

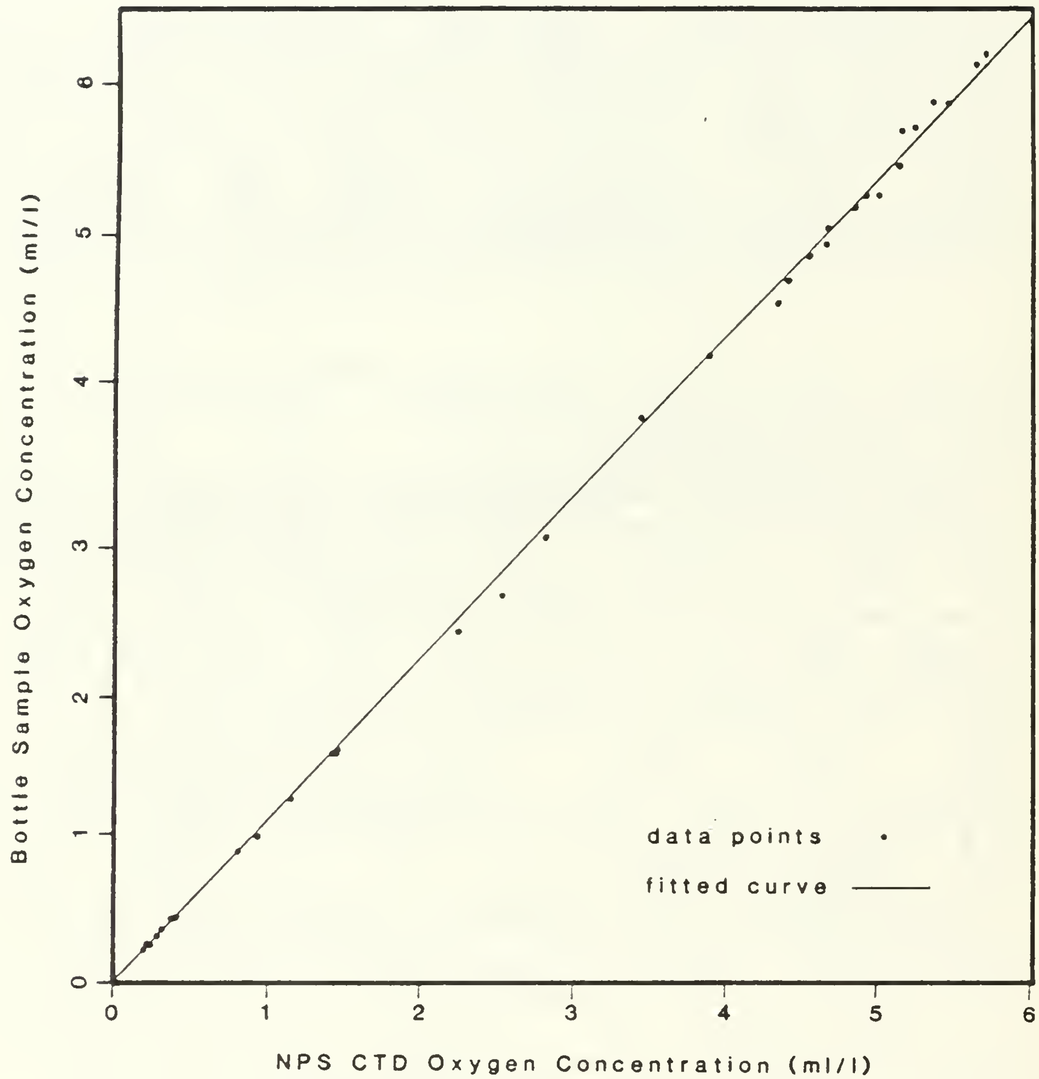

Figure C3. Bottle sample oxygen concentration vs. nominal CTD oxygen concentration (ml/l).

Appendix D

Archive Tape Format Specification

Tape Contents

The ODEX CTD data set is archived on half-inch 9-track magnetic tape. The tape contains 16 files, each written at 1600 bpi, in a fixed block record format with a logical record length of 168 bytes and block size of 4200 bytes.

File Contents

The 16 files contain 197 CTD stations as listed below.

```
file 1........2 - 6, 9 - 15
file 2........16 - 19, 20A, 21 - 23
file 3........24 - 28
file 4........29 - 43, 45
file 5........46, 46B, 46C, 46D, 47 - 54, 55A
file 6........58 - 61, 61A, 61C, 61E, 61G, 61I, 61K,
              61M, 61O, 61Q, 61S, 61U, 62 - 64
file 7........65, 65A, 65C, 65E, 65G, 65I, 66 - 76
file 8........77, 77B, 77C, 78 - 92
file 9........93 - 111
file 10.......112 - 125
file 11.......126 - 141
file 12.......142 - 150
file 13.......151 - 160
file 14.......161 - 165, 168 - 170
file 15.......171 - 178
file 16.......179 - 184
```

Station Data Format

Each cast consists of 4 header records and 201 data records, with each header or data record containing 12 floating point numbers in a 12E14.7 format.

HEADER RECORDS: The 4 header records for each cast constitute a 48 element array containing data from the start and end of each cast as well as a block of CTD processing information (items 37-45). The positions, dates, times, and

CTD processing information have been verified and edited, however the other header data has not been checked for validity and should be used with caution (if at all).

Start of cast	End of cast
(1)time(HHMM.SS)	(19)time(HHMM.SS)
(2)latitude(decimal deg)	(20)latitude(decimal deg)
(3)longitude(decimal deg)	(21)longitude(decimal deg)
(4)heading(decimal deg)	(22)heading(decimal deg)
(5)wind dir.(rel. to bow)	(23)wind dir.(rel. to bow)
(6)wind speed(m/s rel.)	(24)wind speed(m/s rel.)
(7)dew point(deg C)	(25)dew point(deg C)
(8)air temperature(deg C)	(26)air temperature(deg C)
(9)2 meter sea temperature	(27)2 meter sea temperature
(10)2 meter sea salinity	(28)2 meter sea salinity
(11)pyranometer 1	(29)pyranometer 1
(12)pyranometer 2	(30)pyranometer 2
(13)undefined	(31)undefined
(14)barom. pres.(in. Hg)	(32)barom. pres.(in Hg)
(15)surface fluorescence	(33)surface fluorescence
(16)surface transmission	(34)surface transmission
(17)undefined	(35)undefined
(18)date(YYMM.DD)	(36)date(YYMM.DD)

Processing information

(37)cast number(positive for upcasts, negative for down)
(38)number of data points before averageing
(39)fluorometer code number(see below)
(40)ctd code number(see below)
(41)depth of processing (in decibars)
(42)last data element containing hydrographic data
(43)last data element containing beam attenuation data
(44)last data element containing oxygen data
(45)last data element containing fluorescence data
(46)undefined
(47)undefined
(48)undefined

CTD and Fluorometer codes (see header elements 39 and 40 and the discussion in App. B) for the instruments used on the ODEX3 cruise are as follows:

FLUOROMETER	CODE
not present	0
s/n 11 (from BOPS - App. B)	11
s/n 12	12
s/n 13	13
s/n's 12 & 13 (hybrid)	14
s/n's 12 & 13 in log mode	15

CTD	CODE
OSU	0
NPS	1

DATA RECORDS: Each of the 201 data records contains one set of pressure(decibars), temperature(degrees C), salinity, sigma-t, dynamic depth(dynamic meters), specific volume anomaly(cm**3/gm), sound speed(m/s), Brunt Vaisala frequency squared(1/s**2), beam attenuation at 660 nm(1/m), fluorescence(volts), oxygen concentration(ml/l), and oxygen concentration (% saturation), representing data from 0 to 500 decibars at 2.5 dbar intervals.

All stations will have 201 records, however most profiles extend to a maximum of 300 decibars, or 121 records. In these cases, the remaining records contain zeros for each parameter. Header elements 42 - 45 contain the record number for the "last data element" for each type of data. Note that some types of data will extend deeper than others on some casts.

Sample Fortran Subroutine For Reading a Station

The following FORTRAN subroutine may be used to read individual casts from the archive tape.

```
      SUBROUTINE RDFORM(EOF)
C
C         EOF = END OF FILE FLAG, SET TO TRUE IF AN END OF
C               FILE IS ENCOUNTERED WHILE ATTEMPTING TO
C               READ DATA.
C
C
      REAL*4        DEPTH(201)
      REAL*4        TEMP(201)
      REAL*4        SAL(201)
      REAL*4        SIGMA(201)
      REAL*4        DYNDPT(201)
      REAL*4        SVA(201)
      REAL*4        SNDSPD(201)
      REAL*4        NSQ(201)
      REAL*4        C660(201)
      REAL*4        FLUR(201)
      REAL*4        OXYC(201)
      REAL*4        OXYPCT(201)
      REAL*4        HEADER(50)
```

```
C
      COMMON        /DATA/ DEPTH, TEMP, SAL, SIGMA, DYNDPT,
     &                     SVA, SNDSPD, NSQ, C660, FLUR,
     &                     OXYC, OXYPCT
      COMMON        /HDR/ HEADER
C
      INTEGER*4     POINTS /201/
      LOGICAL*4     EOF
C
      REAL*4        DATA(12)
C
C             READ 48 WORDS OF HEADER
C
      J = 0
  100 CONTINUE
      READ(10,9010,END=7000) DATA
      DO 1000 I = 1,12
         J = J + 1
         HEADER(J) = DATA(I)
 1000 CONTINUE
      IF (J .LT. 48) GOTO 100
      WRITE(6,9030) HEADER(37)
C
C        READ THE DATA
C
      DO 2000 I = 1,POINTS
         READ(10,9010) DEPTH(I), TEMP(I), SAL(I), SIGMA(I),
     &                 DYNDPT(I), SVA(I), SNDSPD(I), NSQ(I),
     &                 C660(I), FLUR(I), OXYC(I), OXYPCT(I)
 2000 CONTINUE
      RETURN
C
C         END OF FILE ENCOUNTERED
C
 7000 EOF = .TRUE.
      WRITE(6,9020)
      RETURN
C
C         FORMAT
C
 9010 FORMAT(12E14.7)
 9020 FORMAT(' END OF FILE ENCOUNTERED ON UNIT 10')
 9030 FORMAT(' READING CAST NUMBER ',F8.2)
      END
```

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